The Chemical Age

A Weekly Journal Devoted to Industrial and Engineering Chemistry

VOL. XXVIII. June 24, 1933 No. 730

Notes and Comments

Exports and Imports of Chemicals

CONSIDERED only in strict comparison with the corresponding month of last year, the Board of Trade returns for May, so far as they relate to the exports and imports of chemicals, drugs, dyes and colours, do not reveal a very encouraging state of affairs. Exports of chemical products during the past month amounted to £1,502,956, showing a decrease of £151,107 or 9.1 per cent., on the total for May, 1932. The value of chemical imports for the month was £842,409, representing an increase of £296,607 or 54.3 per cent., and re-exports totalled £38,189, an increase of £888, or 2.3 per cent.

A comparison of the total overseas trade in chemical products for the first five months of the year with the same period of 1932, however, affords much more satisfaction. Exports for this period totalled £7,018,730, a decrease of £552,093, or only 7.2 per cent. Imports amounted to £3,764,103, a decrease of £504,511, or 10.9 per cent. Although the total movement of chemicals has dropped, the net result has been a steady turnover in the balance of trade in favour of Great Britain, imports having fallen by 10.9 per cent. and exports by 7.2 per cent. Corresponding figures in comparison with 1931 show a still greater change in the relationship between the two figures, imports being down by 27.9 per cent. and exports by 8 per cent. So far as re-exports are concerned, the figures for the five months show a total of £209,611, representing a decrease of £97,197, or 31 per cent. compared with 1931, re-exports are down by 62.9 per cent. The contrast between the figures for a single month and those for an extended period serves to show how misleading any given mass of figures may be. Circumstances arise which cause the returns for one month's trade to be carried forward to the next month's account, and it is only by reflecting upon the returns in perspective that we can arrive at a proper interpretation of the position. In our view the conclusion to be drawn from the 1933 figures to date is that the British chemical industry is holding its own in the world's markets, and that it has reason to contemplate the future with a good deal of hopefulness.

Sir George Clayton

IN the chemical industry the honour accorded to Dr. G. C. Clayton has been hailed with acclamation. It is right and fitting that those who are captains of industry should have some distinguishing mark of the nation's appreciation bestowed upon them. In the days of old the squire won his spurs by deeds of derring-do on many a blood-stained field. To-day the nations strive for mastery in the economic field. Soon they will strive, we hope, not against one another, but as allies, against all ills that distress human kind. From whichever angle we regard it, to those who have contributed in any marked degree to the prosperity of industry it must be superlatively fitting that we pay our tribute in well-deserved honours. The courage and generalship needed to achieve pre-eminence in the industrial world are no less in quantity, even if different in character from those needed on the battlefield, or in the political arena. We feel that, not only Dr. Clayton, but many others who have won high position in the chemical industry—amongst them some who served their country well at Ottawa last year—are deserving of similar recognition. The chemical industry holds a unique position in industrial activities, for a strong chemical industry is the foundation of national security.

The Lancashire chemical industry, for instance, is deservedly famous; it has been a prolific school for famous men. The names of Henry, Schunck, Frankland, Roscoe and Schorlemmer arise at once to the mind upon the theoretical side; the names of those industrialists who built the industry are enshrined in the names of their firms. Among these Sir George C. Clayton will occupy a high place. After only eleven years in the laboratory of the United Alkali Co. he was elected to a seat on the board, and remained there until the company was merged in Imperial Chemical Industries, Ltd., in 1927. His value to chemical industry has been acknowledged by a seat on the board of that undertaking also. In addition to these duties the new knight has been a Member of Parliament for eleven years, president of the Institute of Chemistry, and has served on the Advisory Council of the Department of Scientific and Industrial Research, the Fuel Research Board, the Advisory Council of the Board of Trade and the Advisory Council of the Census of Production—truly a distinguished record.

Activities of the Imperial Institute

BEHIND the informative report of the Imperial Institute for 1932, of which we published a series of extracts last week, lies a disconcerting story of financial difficulties which should not beset so important and useful an institution. Founded with the object of diffusing a better knowledge of the Empire and promoting its industrial and commercial prosperity, the Imperial Institute has concerned itself largely with the examination of raw materials from Empire sources and their utilisation in industry. Since 1926 there has been an increase of 20 per cent. in the number of samples investigated in the laboratories and 30 per cent. in the

number of inquiries dealt with, whilst the number of visitors to the galleries has practically quadrupled. Against this record has to be set the fact that during the last three years the income derived from grants from the various Governments within the Empire has fallen by no less than 35 per cent. "The generosity of Sir Benjamin Drage and of Lord Wakefield and his company," says the report, "has alone made it possible to keep the work going." Owing to financial difficulties, no annual report was published for 1931.

Immeasurable advantages have been derived by British manufacturers from the researches conducted by the Institute, but we do not think that industry as a whole has seriously considered the debt which it owes, not only to the salaried staffs, but to the many members of advisory councils and committees who voluntarily give the Institute the value of their technical experience and knowledge. The chemical industry, in particular, is under a considerable debt in this respect. There can be no satisfaction in the statement that the generosity of two individuals and one company has alone enabled the work to proceed, except to the donors themselves. In our view the work should be adequately supported by manufacturers who reap its fruits. It is essentially a case for voluntary support, owing to the widespread nature of the results, but if the voluntary system fails, there should be some means of assessing the benefits received and calling upon those who receive them to contribute to the work in proportion to their obligation.

Health and Efficiency

FROM the standpoint of strict factory economics the employment of men and machines is a matter of capital available, except that the cost for depreciation is less for the human worker than for the machine. Interest and depreciation on a machine may amount to, say, 15 per cent. of the capital cost. On labour it is sometimes calculated as being 5 per cent. so that the capital value of a worker is 20 times the value of the wages paid. When the worker is not up to full efficiency, the effect is the same as—or worse than—when a machine is not efficient. When a worker is away owing to illness, and particularly if he is a salaried worker, the effect is that of the capital lying idle. Just as oil and attention are necessary to the efficiency of the machine, and are properly regarded as a cost upon the machine, so the necessary steps to maintain the human worker in full efficiency should be a charge upon the firm and a definite factor in the cost of manufacture. Even the small concern would do well to employ a medical officer although he might only look in every morning on his normal rounds.. Something of the same idea lay behind the instructive address upon "Industry and Health" given by Lord Leverhulme at the Congress of the Royal Institute of Public Health. The figures he gave indicate that nearly 4 per cent of the workers in industry are away on account of ill-health at any given time; 4 per cent of the capital value of the human workers is thus already a permanent charge upon industry.

Industry may well consider taking more interest in medical prevention of illness. In doing so we commend a careful study of Lord Leverhulme's paper. The use of disinfectants, the issue of a daily dose of vitamin extract, regular medical examination of employers and other preventative measures already in operation at Port Sunlight are all worthy of commendation. The higher paid the employee, the more need is there to safeguard his health; the mental efficiency of a brain worker is more easily disturbed than the energy efficiency of the manual worker, and the resulting inefficiency may do far more damage without obvious detection. From the way in which the world is moving, it would seem that this question of the efficiency of the human element must receive far more attention than has been bestowed upon it in the past. The provision of medical aids to health is only one step. The effect of age on efficiency will be a further step, and a step that will in the future be a charge on industry. It may in the long run be found cheaper to let an employee retire on pension at, say, 60—or even 55—and his place be taken by a younger man than to allow him to "clutter up the ground" when past his prime. The older man has earned his period of rest, and the unemployment problem would be eased. It might be better to pay for pensions to the old, rather than unemployment subsistance to the young.

Science and Crime

THE prospect of a reorganisation of the police force lends point to the necessity, emphasised by Mr. H. T. F. Rhodes in a recent paper before the International Faculty of Sciences, for a strengthening of the scientific branch of the criminal investigation department. Criminals are becoming more and more trained scientists, with a knowlege of many of the things that can be or have been discovered by research, and crime detection therefore tends to become increasingly a matter of chemical and physical analysis. There is no reason why a body of chemists and physicists attached to the police and permanently engaged in police work should not become so expert as to rival the legendary Sherlock Holmes in the ingenuity of their methods. In the provinces as well as in the Metropolis there is an increasing recognition of the need for scientific methods; for example, since Mr. Rhodes read his paper, we notice that the latest scientific appliances for the prevention and detection of crime have been included in the equipment of the new police headquarters at Newcastle-on-Tyne.

The chemist is a professional detective in his daily work, and in the realm of crime detection he may be relied upon to apply himself to his investigations with the same impartiality as he displays in his own laboratory. There is no need to divide the "technical police" into two departments, one for the prosecution and one for the defence, as has been suggested in some quarters, for the whole department, like the police force itself, should be quite capable of sifting the evidence without fear or favour and submitting it to the tribunal which has to decide the issue. All that is necessary is to ensure that the scientific police are recruited with the utmost care. The personnel must not be chosen from the young and inexperienced, but from those who have achieved some eminence in scientific investigation. We commend this aspect of the matter to the attention of the official bodies, the Institute of Chemistry, the Institute of Physics and the British Association of Chemists.

Applications of Cellulose Esters and Ethers

Their Use in the Plastics Industry

CELLULOSE itself was neither plastic nor thermoplastic, but certain derivatives behaved differently from the parent material, said Dr. W. J. Jenkins, of Imperial Chemical Industries, Ltd., in the course of a paper read at the Science Museum, South Kensington, on June 14, in connection with the Plastics Industrial Exhibition. Cellulose nitrate, cellulose acetate and benzyl cellulose, he added, each became softer as the temperature was increased, and suitably modified would take up required forms when pressed at moderately high temperatures. It was on the thermo-plastic behaviour of certain cellulose derivatives that the plastic industry had been built up.

Since 1910 the use of cellulose acetate in the manufacture of plastics had become very important, notably in the manufacture of artificial silk, whilst a secondary development had been the use of cellulose acetate as a base in the manufacture of thermo-plastic moulding powders. More recently there had been considerable development in the manufacture and use of benzyl cellulose, a product which was representative of the ether class of cellulose derivatives. The properties of cellulose coming into prominence with regard to their use in plastics were their tensile strength, elongation, temperature of softening, hygroscopicity, and permeability to water vapour. Investigations of fatty acid esters of cellulose represented by the acetate, mutyrate, laurate, and stearate, had established that the tensile strength decreased as the molecular weight increased.

Cellulose esters and ethers as at present prepared did not possess a sharp softening point, but became soft over a wide range of temperatures, the temperature of softening of the fatty acid esters decreasing in the order, acetates, butyrate, laurate, stearate, and the hygroscopicity and water vapour permeability was in the same order. A similar gradation of tensile strength, elongation, hygroscopicity and permeability to water vapour was shown by other series of cellulose derivatives, *e.g.*, ethyl, propyl, and butyl cellulose. Variation in properties could be introduced by other factors beside the nature of the acid or ether radicle introduced into the cellulose.

Preparation of Cellulose Lacquers

An idea of the general principles relating to cellulose plastics could be obtained by an examination of cellulose lacquers. The use of the word "cellulose" in this connection was not exactly correct, for all cellulose lacquers should be referred to rather as "lacquers of cellulose derivatives." Three types of cellulose derivatives were used to some extent, namely, the nitrate, acetate and benzyl cellulose. The most important from the point of view of quantity consumed and general suitability of properties were the nitrate compositions.

The general principles underlying the preparation and use of cellulose lacquers were well illustrated in the nitrocellulose compositions. The ingredients of a typical enamel as supplied for coating automobiles by spraying were nitrocellulose, gum, plasticiser, spirits, toluene, ethyl acetate, butyl acetate and butyl alcohol. It was usual to prepare the lacquer in four stages: (1) the nitrocellulose base, (2) the gum compound, (3) the pigment base, (4) the thinner. Usually a concentrated solution of the nitrocellulose was prepared, of the order of 20-30 parts to 100 parts of solvent, generally ethyl, amyl or butyl acetate. To this was added a concentrated solution of the gum formed by dissolving the resins in suitable solvents. It was advisable to use highly concentrated gum solution as the solvents for the resin were generally diluents for the nitrocellulose.

The pigments were ground in the presence of the softener and a portion of the solvents, a ball or pebble being used for this purpose, although a long period of grinding was required and the triple mill was therefore sometimes favoured. The requisite weight of pigment paste was then added and the whole thoroughly mixed, final adjustment of the viscosity being made by means of the thinner, which consisted of the solvents and the diluents used in the formula quoted and so balanced as not to cause precipitation when added to the composition.

In formulating a lacquer it was necessary to choose such a ratio of the non-volatile materials as to give the required properties. Thus, when considering a finish for motor cars the film had to be strictly adherent to the undercoats; also pliable, and at the same time hard and tough, and strongly resistant to weather. A series of the films was therefore prepared, containing varying proportions of nitrocellulose, resin and plasticiser, and the degrees of hardness, toughness and pliability of the films tested. When a range of such results was available they were plotted on a diagram, with nitrocellulose, resin, and plasticiser forming the triangular co-ordinates.

Solvents and Plasticisers

With regard to solvents, much was known about the chemical groups which impart to an organic substance solvent properties for nitrocellulose, but only those substances competing in price had much chance of industrial application. Solvents were roughly divided into ketones, ethers of polyalcohols, and esters. Cyclohexanone had the highest solvent power, but was not quite acceptable on account of its odour, which was unpleasant. Ether alone was a non-solvent, and alcohol at ordinary temperatures only softened nitrocellulose, but when suitable proportions were mixed together a good solvent was obtained. The ether and alcohol group in conjunction acted as a solvent and this was accomplished very well by certain organic liquids containing these two. Thus in the case of glycerine, which contained three alcohol groups, if one of these hydroxyl radicles was replaced by an ether group, quite a good nitrocellulose solvent was obtained. A similar case was ethylene glycol. Butyl acetate was a very useful solvent for nitrocellulose, and its solvent properties could be increased by introducing a hydroxyl radicle or decreased by introducing a chlorine radicle in place of one of the hydrogens of the CH_3 radicle. Certain so-called partial solvents, such as alcohols, were more effective when a diluent was present.

From scientific and commercial aspects the plasticising of cellulose derivatives was of considerable importance. This applied equally in lacquers, films and moulding powders. The term plasticiser was not easy to define. Thus, although it was customary to refer to tricresyl phosphate and castor oil as plasticisers of nitrocellulose the action of each was different. Tricresyl phosphate was able to transform a certain grade of nitrocellulose into a transparent gel at ordinary temperatures, whilst castor oil had no visible effect on the same grade of nitrocellulose. This difference had been used to classify plasticisers as "gelatinisers" and "softeners," the former referring to those substances which, like tricresyl phosphate, converted the cellulose into a gel, whilst the latter referred to substances such as castor oil, which possessed plasticising properties although having no visible effect on the cellulose derivatives. The difference was similar to that between certain diluents and solvents.

The Function of the Plasticiser

One of the most important features of a plasticiser should be its permanence; in this respect it was essentially different from a solvent. A plasticiser was required to remain in the material to which it was added whilst the solvent was applied under such conditions that it could be removed completely. Plasticisers as a rule possessed very low volatility, and seldom were materials classed as plasticisers which had boiling points below 250° C. Camphor, which boiled about 209° C., was an exception. Typical plasticisers for nitrocellulose, such as tricresyl phosphate, boiled at about 300° C.

Another direction in which cellulose derivatives were used in considerable quantities was for the manufacture of artificial leather-cloth. The process of manufacture consisted essentially in applying suitably coloured plastic mass of cellulose derivative to a woven fabric, and thereafter impressing the required grain in relief upon the product by means of embossing plates or rolls. Most of the artificial leather-cloth in use at present was made from nitrocellulose, although some was prepared from other derivatives.

Rotenone as an Insecticide

Its Commercial Aspects and Future Possibilities

The commercial aspects and future possibilities of rotenone were discussed by R. W. Birdsall, of Derris, Inc., New York, at a symposium on insecticides, organised by the American Chemical Society, March 26 to 31. The extracts given below are taken from this paper as reported in the June issue of our American contemporary, "Industrial and Engineering Chemistry."

DERRIS root and its various derivatives now have a definite place in the field of commercial insecticides. Although the insecticidal properties of derris root were recorded as early as 1848 by Oxley (called "tuba root" by him), only recently has derris become generally known to the public. This development has been accelerated by the Insecticide Division of the United States Bureau of Chemistry and Soils which through numerous publications has called attention to the possibilities of this insecticide and has determined the structures and the physical and chemical properties of rotenone, deguelin, and tephrosin—active constituents of derris root. Credit is also due to W. M. Davidson of the U.S. Food and Drug Administration and F. L. Campbell and associates of the U.S. Bureau of Entomology for pioneer work with these products.

Shipping and Sampling

Derris grows in Sumatra, Borneo, the Straits Settlements, Java and Sarawak; it can probably be grown in any other section of the world having similar soil conditions and climate. Of the various types of derris root, *Derris elliptica* is the most important. This species has a higher and more uniform content of toxic constituents and therefore is of greater commercial value. Derris from certain regions—for example, the Dutch East Indies—is very poor. Roots have been purchased from practically every reported source, and, through the process of elimination, sources of supplies have been narrowed down to a certain few plantations from which cultivated roots can be purchased with the assurance that they contain a high percentage of toxic principles. In many instances the plants of derris are set out between cultivated rubber trees because this interspersing of the plantings is supposed to benefit the trees.

The bulk of importations to date appears to have come from Singapore and other ports in the Straits Settlements. The average length of voyage is 42 to 48 days. The material is shipped in different kinds of containers. Some suppliers merely bale the roots in long twining strips, a procedure that makes it hard to pull the material apart. Others press-pack the roots, after removing the larger ones, and ship them in tea chests. The bales range in gross weight from 100 to 200 pounds, and it is the custom of the trade to sell gross for net. It is next to impossible accurately to evaluate a shipment by sampling on the dock or in the shipper's warehouse before shipment because of the fact that no two samples of crude root drawn from the same shipment will agree as to the content of rotenone or total ether extract. Significant samples can be obtained only from ground material.

Economical Milling

The economical milling of derris root is perhaps more difficult to accomplish than that of any other material. There is no mill yet manufactured that will do the job entirely satisfactorily. The roots must first be pulled from the containers by hand in small handfuls and fed to a cutting machine, before the material can be placed in a mill. The milling has to be closely supervised, otherwise the material may ignite. The third step reduces the material to an air-floated dust. In other words, three distinct products are obtained from three distinct operations: chopped root, ground root, and air-floated root. The milling is done in lots of 1,000 lb. after which the material is thoroughly mixed by machine and binned. Sampling and assaying can then be satisfactorily carried out. The only accurate way of standardising derris root is to assay each unit of milled product, label it as to its exact rotenone content, and keep it separate so that from a number of different milled units a mixture can be produced of any desired strength.

The ground root may be analysed by the carbon tetrachloride extraction method of Jones ("Ind. Eng. Chem;" Anal. Edit., 1933, *5*, 23); a separate analysis is run for each 1,000 lb. These lots may vary in rotenone content from 2 to 7 per cent; when the roots are cultivated on estates the total ether extractives have been found consistently to be approximately four times the rotenone content. In other words, a root containing 4 per cent. rotenone yields total ether extractives (including the rotenone) of 16 to 17.5 per cent., and a root which contains 5 per cent. rotenone consistently shows total ether extractives of 20 to 22 per cent. As received by this company, derris roots usually contain only 3 to 4 per cent. moisture, the maximum found in material of good quality being 6 per cent. One lot of root from an inexperienced shipper contained 38 per cent. moisture. This shipment had to be dried because mould develops readily on most roots in storage.

The Extraction Process

The process of extracting derris root is about the same as that used in extracting other plant material. The list of workable solvents available has been published by Jones and Smith ("Journ. Amer. Chem. Soc.," 1930, *52*, 2554). Acetone, benzene, carbon tetrachloride, or ethylene dichloride can be used. Material ground to pass a 30-mesh sieve is extracted and 500 lb. are used to each percolator. The rotenone—carbon tetrachloride solvate is the first product obtained when derris root is extracted with carbon tetrachloride and is hence the cheapest form. Its composition is 71.9 per cent. rotenone and 28.1 per cent. carbon tetrachloride, one molecule of each. The next step is the manufacture of "rotenone technical"—that is, rotenone of 90 per cent. purity. This product and C. P. rotenone are made by recrystallising rotenone—carbon tetrachloride solvate from alcohol.

Products and derivatives of derris root now available on a commercial scale in the United States include: Powdered derris root (an air-floated dust) standardised as to rotenone content; derris root resinate, a light brown powder containing ¼ rotenone and ¾ derris root resins; rotenone solvate (71.9 per cent. rotenone); rotenone technical (90 per cent. rotenone); rotenone C. P.; liquid extract concentrated (a solution of 5 grams rotenone plus all other toxic extractives of the root per 100 cc. of solvent, the average solvent commercially sold being acetone); a combination rotenone-pyrethrum household spray concentrate which is sold on a kill basis; and other finished insecticides which are sold in bulk for repacking.

Standard Rotenone Content

Air-floated powder, standardised as to rotenone content, goes mostly into the manufacture of insecticidal dusts. This powder will probably be used extensively this year to control insects on vegetables and other edibles so that the grower may avoid the danger of having a harmful amount of arsenical residue. This material should be purchased from a manufacturer in whom the buyer has confidence because it should be standardised as to rotenone content, and the usual consumer has no way of checking the analysis. Concentrated liquid extracts, standardised as to rotenone content and purified so that they are easily miscible with water, will always have a definite place among liquid insecticides used in hothouses, gardens, etc. The buyer in purchasing this material should be sure that the concentrate contains the stated amount of rotenone so that his finished spray liquid will be uniform. If the work now undertaken to stabilise rotenone against oxidation and sunlight is successful, it is believed that stabilised, concentrated liquid extracts will be used extensively in place of arsenicals on fruits.

The rotenone-pyrethrum concentrate is unquestionably an improvement over the ordinary straight pyrethrum concentrate now used in manufacturing household sprays. It is more efficient not only in controlling flies, but also bedbugs, roaches, moths, and other pests. Gnadinger and Corl ("Journ. Econ. Entomol." 1932, *25*, 1237) have recently published an article giving the results of tests which indicate that rotenone is not so efficient as the pyrethrins as a fly spray. These tests were conducted in such away as to lead the writer to believe that there was little or no rote-

none present in the solution at the time of spraying, or that the rotenone present was in the process of crystallisation dispersed in such large particles that it had no efficiency as a contact insecticide in the liquid spray. In exhaustive tests over a period of 10 months, rotenone-pyrethrin combinations have yielded the following results by the Peet-Grady method ("Journ. Econ. Entomol.," 1928, *21*, 612) for testing fly sprays:

Combined Concentrate Volume	Hydrocarbon Oil Volume	Kill %
1	4	80-92
1	5	81-85
1	6	74-80
1	7	64-74

This table at least proves that, when combination concentrates are overdiluted, the kill does not decrease in direct proportion to the decrease in toxic content. The cost per finished spray gallon, using the combination concentrates, is directly competitive in price with the cost per finished spray gallon using the best pyrethrum concentrates now on the market. Hydrocarbon oil containing 0.1 per cent. rotenone, properly held in solution without pyrethrum extract, kills 65 to 70 per cent. of the flies by the Peet-Grady method.

From experience gained over the past two years, the author is convinced that ground root, if stored under normal conditions, does not deteriorate nor do the various extracts deteriorate if kept out of contact with air and direct sunlight. This is confirmed by the experience of others, one of whom states that derris extracts (suspensions of the milky sap in water) supplied by the Deli Proefstation to tobacco growers for control of aphids retain toxicity for at least one year when kept in well-closed barrels, but decomposition occurs in open vessels and in those not hermetically closed.

The grinding of derris root causes trouble in a great many instances because, if the labourer is not experienced, the breathing of the dust tends to cause numbness of the lips and irritation of the throat.

The demand for derris root or other rotenone-bearing roots in the insecticide trade will undoubtedly increase tremendously year by year. Should derris root run into the huge tonnage now enjoyed by other products, the sources of supply could maintain this business. The northern quarter of South America contains huge quantities of cubé roots or roots of the same type under different botanical or local names, depending upon the country of origin. This market has not been developed in proportion to its possibilities. At present probably not more than 5 lb. of cubé root are sold in the United States to every 95 lb. of derris root. Experience so far indicates that derris root is of greater commercial value because of its larger content of nonrotenone extractives. The costs of all derris derivatives and of derris itself are gradually being reduced, and in the future derris root or one of its derivatives may replace poisons such as lead arsenate.

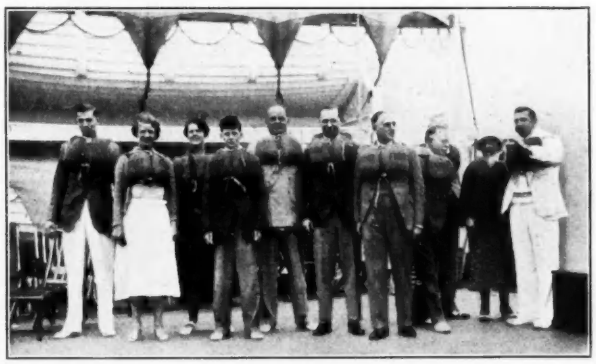
Gas Engineers Visit Spain and Portugal

Cruise in R.M.S. "Lancastria"

AFTER spending a strenuous week at the seventieth annual general meeting of the Institution at Liverpool, a party of members of the Institution of Gas Engineers, with their friends, enjoyed a memorable week's cruise to Spain and Portugal aboard the R.M.S. "Lancastria." A representative of THE CHEMICAL AGE accompanied the party, which also included Mr. J. R. Willis Alexander, secretary of the Institution, members of the chemical industry and the chemical side of gasworks administration.

Visits were paid to Oporto, Bom Jesus do Monte, Corunna and Santiago, and members of the Institution party also distinguished themselves in the "Lancastria" by entering "The Therms" team, which won the all-comers' tug-of-war competition in the gymkhana organised during the voyage.

The cruise was the first social event of its kind organised by the Institution and it is possible that it will become an annual fixture. Early in September, a large party of members of the Institution will leave on a visit to Canada and the United States in response to invitations from the Canadian and American Gas Associations.



Above—Lifebelt Drill. On the extreme left is Mr. G. A. Robinson. (F. Robinson and Co., Ltd.) of Hull.

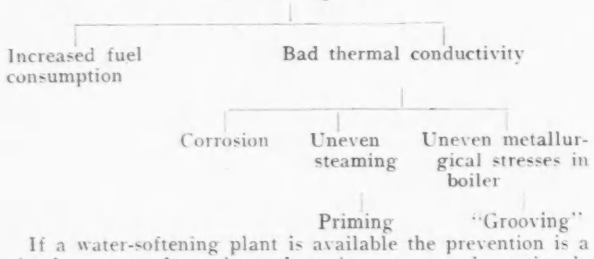
Left—Some members of the party on the Spain and Portugal cruise of R.M.S. Lancastria.

Photos: Marine Photo Service Co., Colchester.

Scale Prevention in the Boiler

By E. A. SMITH

SCALE on the water side of a boiler has many consequences, the primary one being increased fuel consumption per unit of steam raised. This is the weightiest consideration, but there are secondary, and even tertiary consequences, the sum total of which can, in certain cases, amount to more than the cost from fuel loss. The following chart will illustrate some of the ramifications into which one is led by calcareous or other depositions in the boiler:—



If a water-softening plant is available the prevention is a simple matter, but where there is not one, the rationale resolves itself into a fight against the slow progress of the boiler to disuse through the channel of bad thermal conductivity. Fuel losses due to scale are summarised by the following data:—

Authority.	Thickness of Deposit.			
	1/32 in.	1/16 in.	1/8 in.	1/4 in.
Leves	—	16%	—	60%
Wilson	—	15%	—	50%
Calendar	—	—	—	25%
Breckinridiges ...	9%	12%	—	—
Illinois University ...	—	—	15%	—

These figures are common knowledge, yet one still encounters engineers on small works who grumble eternally about maintenance costs when they have as much as a quarter-of-an-inch of scale in their boilers. In such extreme cases it is the engineer himself who presents the problem, not the processes which he controls.

The comparison of thermal conductivity for a clean boiler plate and a scaled one shows strikingly the potential damage that lies in such morbid insulation; the thermal energy represented by the difference in B.Th.U. between col. 2 and col. 3 is transformed through thermodynamical to mechanical energy that finds its expression in buckled plates, boiler distortion, etc.

Boiler Plate Temp. Gradient.	Heat Transmission Rate per sq. ft. of Boiler Surface per hr. (B.Th.U.)	
	Scale Coat 0.21 in thick	Clean Plate
0—100°	6,300	15,000
0—200°	12,500	37,500
0—300°	17,500	45,000
0—500°	30,000	—
0—700°	45,000	—

Physical Characteristics of Scale

The physical characteristics of a scale depend on the composition of the water from which it is deposited, such as conductivity, durability and density. While a carbonaceous water would yield a scale that could be scratched with a finger nail, three grains of magnesium salts present would bond the carbonate into a much more durable coat, owing to the fact that the magnesium salts decompose in the boiler water to give magnesium hydroxide, an effective cement. An analysis of the feed water will give a good idea of the composition of any scale formed. A boiler water had a composition, in grains per gal. of $CaSO_4$ 40.3, $MgSO_4$ 3.1, $NaSO_4$ 254.6, $NaNO_3$ 19.1, Na Cl 93.7, and gave a scale, 6/32 in. thick, in nine months, which was extremely hard and of a high insulating (thermal) value, with the composition $CaSO_4$ 88, MgO 9, Fe 2, Si 0.2 per cent. During the accumulation of this deposit the fuel consumption rose steadily to approximately 125 per cent. of the initial figure, and "grooving" was observed along the lap joints of the boiler, a Lancashire pattern. Remedial measures were undertaken, as there was no softening plant available, by feeding material into the feed water. Caustic soda had previously been tried, and had given alleviation, but this was discarded on the possible steel embrittlement of the plates. Sodium sulphate helped to reduce the scale considerably, and a mixture of the sulphate and carbonate tried, together with a small quantity of sodium aluminate as a coagulant, the results obtained being very promising. It will be understood that to obtain complete prevention of scale it would be necessary to employ theoretical quantities of alkali, which, of course, is quite out of the question with a water containing more than, say, seven grains of incrustating solids per gallon. This difficulty can in most cases be surmounted by the use of a coagulant or disperse medium in conjunction with the alkali, for while the dispersion would be unable to contribute to the formation of scale it would help to inhibit such formation. There are many commercial products suitable for this purpose, such as sodium aluminate, starch, viscose, quebracho, the various galls, tannates, ferrous sulphate and aluminium sulphate, all of which have given results varying from moderate up to excellent. They can be added to the feed water, and allowed to remain in the boiler, with the exception of the aluminate, as they are quite inocuous.

Duration of Steaming

Alkaline soda bases can be used in conjunction with these disperse mediums, such as the sulphates, carbonates, phosphates and hydrates. They all dissociate in boiling water, to give caustic soda, but the phosphate does so to the extent of about 33 per cent., yielding sodium hydroxide and two lower phosphates, which inhibit steel embrittlement. The caustic soda liberated by the dissociation of the triphosphate is absorbed by the calcium and magnesium salts as it is formed:

$$Na_3PO_4 + \text{Water} \longrightarrow NaOH + \text{ortho and dibasic phosphates}$$

$$2CaSO_4 + 2NaOH \longrightarrow Na_2SO_4 + Ca(OH)_2$$

and so limits the activity of the hydrate to simple base replacement. The calcium hydrate is progressively less soluble in water with increasing temperature, the result being that the hydrate precipitates in preference to linking with the phosphate. It is also probable that the conversion from calcium hydrate to phosphate is accomplished slowly in the sludge state in the bottom of the boiler. As regards the disposal of the sludge, the only factor that is required outside the boiler working factors, which should be known, is the total solids in the feed water, in grains per gallon. It is then a simple matter to estimate the duration of steaming before the boiling water reaches a desired concentration, and specify the intervals between blowing down.

Besides the fuel losses due to scale there are the concomitant evils of corrosion. That a boiler water is alkaline is no guarantee of its being non-corrosive. Furthermore, the presence of scale on the plates and tubes does not ensure the protection of the metalwork from the acid salts in the water; corrosion can and usually does go on with insidious activity under the scale, the products of erosion breaking through the scale coat as a carmine trickle of iron oxide. Such an extrusion is known as "bleeding," and is too well known to enlarge upon. Calcium nitrate, magnesium nitrate and chloride are usually present in natural waters in small quantities, and give an alkaline reaction to phenolphthalein and methyl orange.

A Case of Continuous Corrosion

It often happens that a water showing in its analysis a total quantity of sodium nitrate, magnesium nitrate and chloride less than three grains per gallon is passed over as being harmless, until experience with it in the boiler harshly disproves the judgment. The following reactions represent what happens in the superheated water, calcium nitrate being taken as an example:—

$$Ca(NO_3)_2 + H_2O \longrightarrow CaO + 2\,HNO_3$$

The nitric acid reacts with the boiler metalwork thus:

$$Fe + 2\,HNO_3 \longrightarrow Fe(NO_3)_2 + H_2$$

with the appearance of the metal in the solution:

$$Fe(NO_3)_2 + CaO \longrightarrow Ca(NO_3)_2 + FeO$$

Small quantities of dissolved carbon dioxide—and there will be plenty of the gas if the water contains much carbonates—

and formates will catalyse the above reactions, giving rise to continuous corrosion.

Corrosion can be divided into three distinct types: (1) pitting, (2) grooving, and (3) uniform corrosion. The first type is usually caused by the localised action of nitrates and chlorides as given in the above equations, the localisation being due to the locking-in of the active constituents by the scale. Grooving is due, in most cases, to scale setting up uneven stresses in the boiler plates, with consequent fine cracking along longitudinal planes, and the entry of the corrosive constituents of the water into the interstices. The third form of corrosion arises in many instances from the incomplete softening of the feed water, and effects uniformly the plates, lap-joints circumferential seams, the roots of angle irons and rivets. It will be seen that scale, with all its consequences must be tackled, or else the processes dependent on the steam output will suffer and the life of the boiler be considerably reduced. In regard to commercial preparations for the prevention of scale by treatment of the boiler water, the author has personally investigated the claims of two such preparations and has found them entirely effective over a considerable range of natural waters.

Computation of Profits for Income Tax Purposes

By S. HOWARD WITHEY, F.C.I.

At the close of the financial year or other accounting period, the chemical engineer or manufacturer, whether carrying on business on his own account, as a partner of a firm, or as a director of a limited liability company, will naturally make a special effort to ensure that all expenses and business charges affecting the results are debited to profit and loss, before the balance of profit is withdrawn from the business for private purposes, or shared between partners in accordance with the terms of the deeds, or distributed in the form of dividends to shareholders, as the case may be. Although the profit balance may represent the margin actually realised during the period under review, this figure will not actually be accepted by the Inland Revenue authorities when computing the amount of income tax payable under Schedule "D." In point of fact, the tax officials are not so much interested in determining the margin of net profit realised in chemical engineering or manufacturing processes as in the taxable profit, and to arrive at this they are compelled to conform to certain definite rules in the matter of allowances. Consequently, it is always advisable to tabulate the final figures in a form that will facilitate the determination of the figure to be subjected to tax, and enable the maximum relief to be obtained.

Legitimate Deductions

Expenses, charges and operating losses, also the gains, incoming, and trading profits, should be separate, as far as possible by grouping together all items of a similar nature. Some of the amounts which have been charged against profits, or deducted from amounts appearing on the credit side of the periodical profit and loss account, will not be allowed to stand as legitimate deductions, while on the other hand allowances of a special nature may be claimed quite apart from the amounts actually debited to the account. For example, items representing the cost of extending or improving the business premises, laboratory, or interior fixtures and fittings, although they may be regarded by the manufacturers as proper charges against profits, are not statutory deductions, and the same applies to the cost of replacing such assets as calcining plant and dryers, tanks, and pressure vessels, etc. While ordinary repairs to rotary blowers and exhausters, compressors, and pumps will be allowed, depreciation written off the book value will have to be added back to the balance of profit for tax purposes, the taxpayer being granted a more or less inadequate wear and tear allowance intended to cover worn or damaged parts. Expenditure incurred in the maintenance of any asset is as much a charge against profits as are the salaries paid to engineers and chemists, but if the effect is to increase the value of the profit-earning equipment, the expenditure should be capitalised by debiting the amount involved to the private ledger account.

Periodical Payments

The salary or private drawings of the proprietor or partner, whether in respect of whole-time service or invested capital, when charged against profits, will have to be added back for tax purposes, as no remuneration can be drawn from the business except as an appropriation of profits which have actually been realised, and this applies to any payments which may have been made to an inactive partner, while expenses incurred in connection with the raising of capital, or the re-organisation of the existing capital, should be treated as capital outlay and not as profit and loss items. Annual or other periodical payments such as ground rent, interest, etc., while constituting a proper charge against profits, will be disallowed on the grounds that income tax should have been deducted at the time of payment.

Provided the total sum involved is not materially in excess of the average for the last three or four years, the cost of renewing automatic temperature controls, oil film air filters, industrial safety appliances, and trade utensils, will be allowed to stand as a deduction, as also will the cost of maintaining the business premises in a proper state of repair. Bad debts, actually written off, may be charged against profits, including a reasonable reserve against debts of a doubtful nature. If the business premises belong to the taxpayer, the Schedule "A" assessment may be deducted, the gross amount being debited if no charge for repairs has been included in the account, but the net figure if property repairs have been charged against the periodical profits. Although local rates and taxes on the business premises is a legitimate deduction, income tax payments will be regarded as part of the profits realised. Loss of chemicals or chemical products resulting from fire, burglary, or embezzlement, may be charged, and the same applies to expenses incurred in connection with the removal of stock, or in the compulsory transfer of the business. When rents received from subtenants, or in respect of property owned, are treated as income in the final accounts, the sum involved may be deducted from the balance of net profit, provided no charge has already been made in connection with the same premises.

Balance of Taxable Profit

To ascertain the balance of taxable profit, it is always advisable to prepare a special income tax profit and loss account showing, on the right hand or credit side, the figure of profit appearing in the ordinary profit and loss account, followed by the various deductions which are not allowed by law, and on the left hand or debit side, the different amounts and allowances to which the proprietor, firm or company is legally entitled apart from those already charged against profits. Some chemical engineers in a comparatively small way of business, and unable to prepare a reliable profit and loss account, base their computations on actual cash records, a summary of the cash received and cash paid being made out, the amount by which the closing cash balance exceeds the opening cash balance being regarded as profit realised during the period. In such cases it is important to bear in mind that in order to arrive at the correct figure of taxable profit, certain additions to and deductions from the profit figure will have to be made, in addition to those enumerated above. For example, if the total sum owing by customers and debtors at the end of the period is greater than the amount which was outstanding at the beginning of the period, the difference should be treated as profit, but if the book debts register a decrease, the difference may be regarded as a loss to be deducted from the profit figure. An increase in the value of stock should be regarded as profit subject to tax, while if the stock has decreased in total value, the difference may be charged against profit. With regard to the sum owing to creditors and trade suppliers, if the amount is less than the corresponding figure at the commencement of the period, the difference is taxable profit, but on the other hand, if the creditors have increased in total, the increase may be dealt with as a loss.

Recent Developments in Textile Finishing

By L. G. LAURIE. A.I.C.

The following notes are from a paper presented at the Annual Conference of the Textile Institute, held at Harrogate, June 7 to 9. The author of this paper pointed out that research on the utilisation of by-products in the chemical industry has been of great benefit to textile finishing, hitherto a neglected field.

THE post-war period has been one of remarkable activity in providing new products and new processes for the finishing of textile materials. The majority of discoveries originated, not within the industry itself, but from outside, and nearly every branch of finishing has benefited in one direction or another. A characteristic feature of this development has been the enormous number of textile chemical products, over a thousand, excluding dyestuffs, which are actually on the market for use in various finishing processes. These products are designed either to effect simplification in a process or to produce improved, or in some instances, entirely new results on various textile materials.

The introduction of sulphonated or sulphated fatty alcohols as detergents is one of the most outstanding post-war discoveries in the textile industry. Sulphonation has, in recent years, played a most important part in the preparation of new products of application to textiles. Thus the sulphonation of castor oil provided a soluble type of oil suitable for many finishing processes but which possessed no detergent power and which was not stable to hard water or to metallic salts. The introduction of more highly sulphonated products such as Avirol AH (Böhme) and Prestabit Oil V (I. G. Farbenindustrie) was a considerable advance, as these products possessed a very high resistance to hard water and metallic salts and could actually be used in heavy Epsom salt finishes as softening agents. Monopole Soap (I. G. Farbenindustrie) —a polyricinoleic acid type was another notable advance in the same direction. In 1931, the I. G. Farbenindustric introduced Igepon A which is a sulphonated fatty alcohol and about the same time similar products, Gardinols (Böhme) were put on the market. These compounds not only possessed an extremely powerful detergent effect, being suitable for washing and scouring all types of textile materials.

Wetting and Emulsifying Agents

Another class of compounds which has become definitely established in the textile industry is that of wetting agents. During the past few years a number of wetting agents of exceptional power and exceptional value have been introduced which are quite different from soap and other old forms of wetting agents. The products on the market may be roughly divided into three main classes. There is first the type represented by Nekal BX (I. G. Farbenindustrie)—an alkylated naphthalene—sulphonic acid, and Perminal W (Imperial Chemical Industries), Invadene N (Society of Chemical Industry in Basle) and others; secondly, the type of highly sulphonated oil or fatty compounds such as Prestabit Oil B (I. G. Farbenindustrie) and Avirol AH (Böhme), and thirdly, a number of wetting agents are being used for special purposes as for use with mercerising liquors such as Perminal MERC (Imperial Chemical Industries), Mercerol (Sandoz), etc., which are mostly phenolic compounds. In order to appreciate the value of these agents, their definite limitation must be recognised. They act either by increasing the speed of wetting, by ensuring greater uniformity of treatment, or by giving better penetration of the liquid and one or other of these factors is the main reason for using a wetting agent.

Among new emulsifying agents introduced in the wool industry for the preparation of oil emulsions to be used in spinning, are Nekal AEM (I. G. Farbenindustrie) and Perminal EML (Imperial Chemical Industries) both of which are extremely powerful emulsifying agents and possess a distinct advantage over the older type, in that they are resistant to acid, alkali and hard water. One of the most recent additions to this class of compound is Emulphor O (I.G. Farbenindustrie), a most interesting product which is of particular value in the preparation of emulsions of oleine for spinning creams. According to the patent literature, this product may be a polypthylene glycol condensation product and if so it opens up a new class of most interesting substances for use in the textile trade. A further new product, Diazopon A, may also be considered as a dispersing agent although its main use appears to be to improve the rubbing fastness of azoic dyeings—in which connection it very probably acts through its powerful dispersing properties.

Fixing Direct Cotton Dyestuffs

One of the most recent discoveries of particular interest to both dyers and finishers, is that of a new fixing agent which has been marketed under the name of Fixanol by Imperial Chemical Industries. This product is an entirely new compound which has been designed for the fixing of direct cotton dyestuffs. It possesses a pronounced affinity for textile fibres whilst at the same time it is capable of combining with direct cotton dyestuffs to produce shades noticeably faster in many respects than the normal dyeings. Direct colours dyed in the normal manner and after-treated with Fixanol are rendered fast to water and acid cross dyeing, perspiration and wet rubbing. The practical advantage of such a range of direct dyeing colours after-treated in this manner is considerable. For the first time one is able to render these colours fast to cross dyeing so that union material need not now be dyed first with acid colours and after-treated with Fixanol first and subsequently cross dyed with acid dyestuffs.

Still another entirely new departure is the introduction of a new stripping agent Decamine A (Imperial Chemical Industries). In the presence of a reducing agent Decamine A will strip the fastest of the fast to kier-boiling azoic colours to a white after a few minutes treatment at the boil. Turkey Red can also be readily stripped to a white whilst it is also of considerable value in stripping the fast anthraquinone vat colours.

Modern Cosmetics

Dangers of Certain Chemical Ingredients

THE injurious effects of certain cosmetics are emphasised in the current issue of the "British Medical Journal," where powders, lipsticks, cold creams, vanishing creams, depilatories, hair dyes, wrinkle removers and hair lotions are examined by Dr. Alice Carleton, assistant physician in the Department of Dermatology, Radcliffe Infirmary, Oxford.

Dr. Carleton refuses to condemn cosmetics outright. She comes to the conclusion that the most dangerous powder ingredient, to which most of the recorded instances of poisoning from this source are due, is lead, although this danger has long been recognised, and its use by reputable firms is now abandoned. Apart from lead and bismuth, toilet powders appear to cause no harm except to individuals who are hypersensitive and may sometimes fall victims to asthma or hay fever from certain colouring matter. Lipsticks consist of a varying mixture of paraffin, lanolin and spermaceti with a dyestuff; they scarcely ever cause irritation. The rare case of chelitis from this source is generally due to the dye, and disappears as a rule with a change of lipstick. Cold creams are mixtures of fat and water, with or without the addition of other ingredients. Some face creams contain lead or mercury in the form of white precipitate or calomel, and a case of chronic lead poisoning due to the use for twelve years of a certain cream is mentioned.

Astringent lotions sold as wrinkle removers are admitted harmless. If metallic hair dyes are used frequently they will in time give rise to symptoms of chronic poisoning. Paraphenylendiamine is not only an irritant of the skin, but may produce gastro-intestinal and nervous symptons, including retrobulbar neuritis. Several fatal cases have been recorded, and its unrestricted sale is now prohibited in Germany, Austria and France. Among substances used for hair-bleaching are oxalic acid and hydrochloric acid, the danger of which need hardly be stressed. More disturbing still is the employment for this purpose of potassium cyanide. Cases of dermatitis or chronic intoxication have from time to time been traced to the use of hair lotions.

Cold Tar for Road Making

By Professor Dr. MALLISON, of Berlin

The extracts given below are from a paper presented at the Plenary Session of the International Road Tar Conference held at Lucerne on June 14. Mr. W. E. Cone, Technical Adviser to the British Road Tar Association, presented a paper on "Tar Concrete."

IN Germany we understand by the expression "cold tar" a road tar which, by the addition of an easily volatile solvent is diluted to such an extent as to enable it to be laid on the street in liquid form at the usual temperature. Certainly tar emulsions are also cold fluid, but the cold fluidity of these emulsions is achieved by the tar, as an emulsoid, being distributed in the finest droplet form in water acting as a continuous medium. Whereas tar emulsions lose for the most part their water and become agglutinative through breaking and also through vaporisation of the water, the cold tars acquire their binding qualities only through the vaporisation of the easily volatile oil which is added. It is true that aqueous cold tars have also existed containing a certain amount of water as well as the easily volatile oils, but they represented intermediate links between the genuine cold tars and the water-in-tar-emulsions, and they have vanished from the market.

Attention must be directed to the fact that a certain confusion in regard to the nomenclature of these cold liquid binding materials prevailed. The asphalt industry understood by the expression "cold asphalt" not an asphalt solution, but an emulsion of asphaltic bitumen. The tar industry took the lead here in distinctly separating the ideas, with the result that the asphalt industry in its turn has recently determined to make a distinction between bitumen emulsion on the one hand and cut back asphalt on the other.

The Question of Viscosity

Strictly speaking, one should understand by a cold liquid binding material, a substance which permits of being applied to the street, laid on and sprayed, without heating at any temperature, *i.e.*, in any season. Such a demand is not easy to meet. This degree of fluidity can, of course, be obtained without difficulty either by selecting a thin fluid starting tar, or by adding to a viscous tar very considerable quantities of solvent. Both methods, however, have their drawbacks. A cold tar proceeding from a thin fluid tar obtains the binding power sufficient to bind the stone only after too long a time has elapsed; again cold tar with much solvent contains little binding substance, and is also relatively expensive. It was a question then of finding a middle way. To all appearances the development follows two different courses. Either a cold tar is prepared, which in summer possesses the correct thin fluidity, but which must be heated up a little in cooler seasons, or two kinds are placed on the market — a thin liquid and a more viscous kind, which are applied according to the season. It will also depend on whether or not the consumer possesses spray devices capable of being heated; according to circumstances he will decide on the cold tar which can be heated, or on the thin fluid cold tar. It also makes a difference whether the cold tar is to be used merely for painting damaged places or for surface tarring with spray devices, or for the manufacture of tarmacadam by shovelling together or in mixing machines.

Thus the whole question of viscosity of the cold tars cannot be answered simply by saying the cold tar must always be essentially thin liquid. Allowance must be made here for economic considerations, the peculiarities of the application and finally the respective purposes to be achieved. Naturally a high degree of fluidity of the cold tar can be arrived at if a very rapidly boiling and vigorously liquefying solvent is used; preparations of this nature are also on the market and enjoy extensive application. Again they possess the drawback, however, of being very easily inflammable. Despite the fact that they are really not to be heated, there still remains the danger of their being heated in case of need, or inadvertently coming into contact with fire, owing to carelessness. Hence one sees, when deciding on the selection of a cold tar specification that "there are two sides to everything," and generally, of necessity, the decision amounts more or less to a compromise.

There is still another point to be added, which must play in the preparation of a cold tar, apart from viscosity and inflammability, and that is the question of whether one desires to bind stones, *i.e.*, repair a hole or prepare a tarmacadam, or to carry out the restoration of an old tarred surface. In the first two cases it will mean a high content of vigorously binding substance, *e.g.*, an agglutinant pitch; in the last one, however, it will depend on a certain content of tar oil which is able to soften and make the hardened layer of tar pliant again. Both spheres of cold tar application have gained great importance in Germany.

If we summarise the foregoing, it will be evident that the laying down of clear simple rules of quality for cold tar is fraught with unusual difficulties. The merit of having made the first start in Germany, and of at least having laid down a preliminary outline for such rules belongs to the Deutschen Strassenbauverband. These rules are summarised in the following table:—

	Cold Tar I	Cold Tar II
Viscosity in the road tar consistometer (nozzle 4 mm.) at 30° in secs. ...	under 20	20-150
Water, not more than per cent. by weight	0.5	0.5
Heavy oils and anthracenic oil together at least per cent. by weight	16	16
Pitch residue, converted to 67° m.p., at least per cent. by weight	40	50
Phenols, not more than per cent. by volume	3	3
Naphathalene, not more than per cent. by weight (incl. analyt. approximative limit)	3	3
Crude anthracene, not more than per cent. by weight (incl. analyt. approximative limit)	3	3
Free carbon within per cent. by weight	4-16	4-16
Flash point (Pensky Martens)	To be stated.	
Content of ash, not more than per cent. by weight	0.5	0.5

If we examine this table in detail we see at first a fundamental separation of a thinner kind (I.) and a thicker kind (II.). The measuring of the viscosity proceeds with the consistometer at 30° in the same way as with the German hot tars; as however the 100 mm. nozzle would cause a too rapid and inaccurate reading of the cold tar discharge, a nozzle of 4 mm. diameter has been inserted in the consistometer for this purpose, and we then receive second values which are easy to read. The limit thin fluid, viscous, has been laid down at 20 secs. In order to make clear to the roadmaker the meaning of these figures, it should be mentioned that a distance of 20-150 secs. with the 4 mm. nozzle corresponds approximately to a distance of 1-5 secs. with the 10 mm. nozzle. The more viscous cold tar would accordingly be approximately as viscous as the thinnest standard hot tar. The limit of 20 secs. was so selected from practical experience, because cold tars can be sprayed with this or with a lower viscosity even at cooler temperatures without heating, whereas cold tars whose viscosity lies considerably above 20 secs., require heating up to 30-50° in cool weather.

Distillation Limit and Flash Point

With regard to the distillation limits, the statements in the table have been kept intentionally brief and vague as the preparer must be granted a certain liberty here, and the variety of the solvents naturally forbids the laying down of more accurate statements. The figures for oils, pitch residue, phenols, naphthalene, crude anthracene and free carbon have, therefore, only been put forward to demonstrate the combination and to prove that a good road tar served as a basis for the preparation of the cold tar.

The determination of the flash point gives the analyst an idea as to the nature of the solvent and to the practician a gauge as to the inflammability. The flash point must be determined in the closed crucible, Pensky-Martens apparatus, for when heating in the open Marcusson crucible very light parts of the solvent, such as carbon disulphide would vaporise even during the determining of the flash point. This would cause one to be misled into determining the flash point too high. In this case, the danger would be present in practice of explosive mixtures of air and solvent vapours forming in half filled barrels, which, when handled carelessly (lighted

cigarettes, etc.) could lead to the explosion of the barrel. Experience has taught that a limit must be drawn at a flash point of about 30°; in cold tars having higher flash points danger is practically non-existent. If a Pensky-Martens apparatus is lacking, this can be shown in the following way. Fill a ¼ litre bottle about halfway with the cold tar to be tested, and leave the bottle standing, well corked, for about two hours. Afterwards draw the cork with the left hand and with the right dip a lighted match into the air-filled space above the cold tar. Observe when doing this whether a flash occurs or not. This test is perfectly safe and yielded a clear illustration in the preparation tested by the author.

The Dimethyl Glyoxime Reaction for Nickel

By EDWIN C. RIGHELLATO, B.Sc.

AMONGST the many excellent organic reagents known for the detection and estimation of elements and radicals, there are few so well established as dimethyl glyoxime for nickel. Familiarity with this reagent, however, appears to have led in recent years to a rather mistaken and exaggerated idea of its accuracy and limitations, and it seems desirable that a review of the facts should be made.

Statements that one part of nickel can be readily detected in twenty million parts of hardened oil and the like by dimethyl glyoxime are only too frequent in the technical Press. O. Brunck ("Zeit. f. angew. Chem," *20*, 1844) first demonstrated the use of dimethyl glyoxime for the estimation of nickel, and claimed that by this method one part of nickel could be detected in 400,000 parts of water, provided the precipitation was effected in a neutral solution of the nickel salt to which either caustic alkali, alkali acetate, or ammonium hydroxide were subsequently added in just sufficient quantity to neutralise the mineral acid liberated in the course of the reaction.

In the course of many estimations of nickel in nickel ingots, shot, alloys and salts carried out by the author by the method of Brunck, the claims of the latter in respect of the sensitivity of the reaction have been substantially confirmed. If approximately 0.2 grams of nickel is precipitated as nickel glyoxime by the recommended procedure in a volume of solution of 500 cc., the nickel glyoxime filtered off through a sintered glass Gooch of close texture and the filtrate evaporated down to about 30 cc., then on making this solution faintly ammoniacal a further one or two milligrams of nickel separates as nickel dimethyl glyoxime. These figures correspond to one part of nickel in 500,000 parts of solution and one part of nickel in 250,000 parts of solution respectively. Various modifications in the general procedure showed no appreciable change in these figures. Nevertheless, working with pure nickel it was possible, by taking account of the nickel glyoxime recovered, to account for at least 99.98 per cent. of the sample taken.

Limited Sensitivity

There is little room for doubt that the sensitivity of the dimethyl glyoxime reaction is limited by the solubility of nickel glyoxime in water. This fact has been further confirmed by P. Nuka, who in a recent publication ("Zeit. f. anal. Chem.," 1932, *91*, 29-32) advocates the advisability of allowing the nickel dimethyl glyoxime precipitate to stand for at least an hour prior to filtering, and of washing it with cold water. It will be evident from the foregoing that when the amount of nickel in a solution reaches an amount of less than one part in 400,000 that the use of dimethyl glyoxime as a precipitant is no longer possible. Detection may be possible by concentration of the solution. Even so, this would not permit an accurate estimation. This fact was recognised by B. Jones ("Analyst, 1929, *54*, 582) who showed that when a solution containing a minute amount of nickel is treated with dimethyl glyoxime, ammonium hydroxide and an oxidising agent (PbO_2, Br_2 and HClO are amongst those recommended) a strong brown colour is developed by means of which the nickel can be determined colorimetrically by comparison with a standard. This is certainly the method to be used when dealing with traces of nickel.

Attention should also be called to two other oximes which give insoluble precipitates with nickel and possess certain definite advantages over dimethyl glyoxime. According to F. W. Atack ("Analyst," *38*, 318) alpha benzildioxime is capable of detecting one part of nickel in 2,000,000 parts of water. This reagent has also an additional advantage over dimethyl glyoxime in that the compound formed with nickel has a much higher molecular weight than that of nickel dimethyl glyoxime and consequently a much smaller factor for the conversion of the compound to nickel, *viz.*:

Weight of nickel alpha benzildioxime × 0.01093 = Nickel.
Weight of nickel dimethyl glyoxime × 0.2032 = Nickel.

The insoluble compound formed by fural dioxime with nickel is soluble in water to the extent of only one part in 6,000,000 and hence as a precipitating reagent for nickel is more sensitive than either dimethyl glyoxime or alpha benzildioxime.

The Physical Society

Guthrie Lecture delivered by Professor Siegbahn

THE tenth Duddell Medal was presented to Professor Wolfgange Gaede, at a meeting of the Physical Society, held at the Imperial College of Science and Technology, Kensington, on June 16. The presentation was followed by the delivery of the eighteenth Guthrie Lecture, given by Professor Manne Siegbahn, of the University of Uppsala. The title of the lecture was "Studies in the Extreme Ultra-Violet and the Very Soft X-Ray Region."

It is largely due to Professor Siegbahn's experimental skill, backed by a wide knowledge of physical science, that our present acquaintance with atomic structure has made such remarkable progress. In 1912 von Laue first gave experimental proof that the X-rays resembled light in all respects except that the lengths of their ether waves were many thousands of times shorter. His method was based upon the supposition that the ordered array of the atoms in a crystal would act upon X-rays just as, in familiar ways, a grosser array of particles or lines or obstructions of any kind act upon the longer waves of light, so causing such phenomena as the colours of mother-of-pearl, or the irridescence of the wing cases of certain insects. This successful experiment at once opened the way to two separate lines of research, both of which have been rich in results. The first has led to our rapidly growing knowledge of the crystalline state of matter, including the bodies which are crystals *par excellence*. The other was first followed by Moseley and Darwin, who employed the new methods in the investigation of the X-rays themselves. Moseley, after discovering and enunciating a law, which has proved of the highest importance to atomic physics, joined the army and was shot at Gallipoli. It was then that Siegbahn, following the same line of research, began his investigations. He effected improvements in the design and construction of apparatus for measuring the wave lengths of X-rays which have endowed them with an accuracy comparable with the corresponding optical instruments.

It is amazing to look back over the last twenty years to the experiments with which this work began, and to compare their crudity, which nevertheless could not hide their obvious importance nor the magnificence of their promise, with the finish of to-day. It is largely to Professor Siegbahn that we owe modern precision and the fulfilment of that promise. His extremely accurate measurements of the lengths of the waves which the various atoms emit, serve as definite indications of their internal structure, and every improvement has brought new and valuable information. It is interesting to note it was Angstrom, also a Swede, who first realised the accuracy in optical measurements which necessitated the choice of a special unit of length for their description. The Angstrom unit is the hundred millionth part of a centimetre. Angstrom actually measured the waves of light and found them to be a few thousand of his units; the wave lengths of X-rays, however, are of the order of a single unit.

Fermentation Processes

Yield of Alcohol

SYSTEMATIC examination of the influence of different classes of organic substances upon alcoholic fermentation processes was commenced some years ago by Italian investigators. Following on two papers on the subject in "Giornale di Chemica Industriale ed Applicata," 1926, *8*, 555, and 1932, *14*, 450, a third series of results are discussed by Mameli and Mossini in the April, 1933, issue of the same journal (p. 161). These workers have now succeeded in demonstrating that the stimulating effect upon alcoholic fermentation previously shown to be exercised by aliphatic and monocyclic compounds containing olefinic linkages is paralleled in the case of more complex classes. The effect is observed, for example, in the presence of olefine linkage — containing naphthalenes, indenes, anthracenes and cholesterols. In all cases, modification of the molecule by introduction of olefinic linkages either causes these substances to exert a favourable influence upon alcoholic fermentation reactions or intensifies an already existent action. In the light of the data so far available, the following generalisation may also be made. The influence of cyclic substances upon alcoholic fermentation is less pronounced when the olefinic linkage is in the nucleus than when at the end of the side chain. In the latter event, furthermore, the effect is intensified by increasing length of chain.

Transparent Paper

Manufacture from Scrap Celluloid

TRANSPARENT foil manufacture is a promising outlet for cheap scrap cinema film which is comparatively little known. According to a recent account of the process by J. Eggert ("Nitrocellulose," April 1933, p. 59), in the crude state the sheet of foil is obtained by similar methods to those adopted in the manufacture of cinema film base itself. The subsequent stages—denitration, bleaching and drying—can be compared to those practised in the production of nitrocellulose rayon.

The choice of solvents for the initial stage will depend upon whether they are to be removed later by the dry (evaporation) or wet (coagulation) process. In the former case, rapid volatilisation is naturally the prime consideration while the wet process calls essentially for solvents which are readily soluble in the aqueous coagulating bath. In connection with the dry process it must also be remembered that solvent recovery is of the utmost economic importance, and that the fewer the ingredients of the solvent mixture, the lower the costs of recovery. A "universal solvent" recommended for the dry process consists of a 1 : 1 mixture of methyl alcohol and methyl acetate. In the early days of the wet process, absolute ethyl alcohol was put forward, but a much less expensive solvent is a mixture of 94 per cent. methyl alcohol, 2 per cent. ethyl alcohol and 4 per cent. ether. No attempt is made to recover the last two ingredients, but the methyl alcohol should be recovered in full. Since, however, ethyl alcohol yields foils of superior mechanical strength, better results are obtained with a solvent mixture composed of three parts of ethyl alcohol and one part of ether.

The Denitrating Bath

After evaporation of the solvents or removal by coagulation (appropriate plant for the two methods being described in the original article), the nitrocellulose foil passes to the denitrating bath which should preferably contain magnesium sulphydrate in presence of substances which prevent precipitation of magnesium hydroxide upon the foil. The latter include calcium, sodium and ammonium sulphydrate. When using the latter substance, care should be taken to avoid development of free ammonia in the bath. The bath must be maintained at 30-75°C. and the period required for denitration (to 0.3 per cent. nitrogen content) varies from ¾ to 2 hours according to the foil thickness. The denitrated foils, consisting substantially of regenerated cellulose, are then washed in warm water and then treated in 2 per cent. hydrochloric acid bath. A second washing operation preceeds transference of the material to the bleaching bath. The physical properties of the bleached material are improved by treatment with glycerine as is the case with transparent foil derived from cellulose xanthate (viscose).

World Power Conference

Appointment of the British Delegates

A FULL list of papers to be presented at the sectional meeting of the World Power Conference, in Scandinavia, between June 26 and July 7, as well as at the first congress of the International Commission on Large Dams of the World Power Conference, to be held at the same time, is published in Bulletin No. 5, issued in connection with the meetings.

The British Government will be represented by two official delegates, Mr. A. E. L. Chorlton, M.P., president of the Institution of Mechanical Engineers, and Dr. F. S. Sinnatt, director of Fuel Research. Mr. Chorlton has accepted appointment by the British National Committee as head of the British delegation. The British National Committee has now made the following additional appointments :—

Official Delegates :—Sir Andrew Duncan, chairman of the Central Electricity Board, Sir David Milne-Watson, governor of the Gas, Light and Coke Company and president of the National Gas Council, and Sir Harold Hartley, vice-president of the London, Midland and Scottish Railway and chairman of the Fuel Research Board.

Honorary Official Delegates :—Sir Archibald Page, general manager of the Central Electricity Board, Dr. E. W. Smith, technical director, the Woodall-Duckham Companies, Mr. Roger T. Smith, past president, Institution of Electrical Engineers, and Mr. H. E. Mitton, of the Butterley Co., Ltd.

Forty-eight British participants have already completed membership application forms. It is probable that there will be a total British membership of nearly sixty. Especially in view of present economic conditions, these figures afford strong evidence of widespread appreciation of the value of the Conference. Copies of Bulletin No. 5 will be supplied upon request by the British National Committee of the World Power Conference, 63 Lincoln's Inn Fields, London, W.C.2.

Phenolic Resins

Lecture at the Plastics Exhibition

THE phenolic types of plastics and their uses were dealt with by Mr. George Dring at a further lecture given in connection with the Plastics Industrial Exhibition, at the Science Museum, South Kensington, on June 7.

Phenolic-formaldehyde resins, said Mr. Dring, might be made not only with crystalline phenol, but also with cresols, xylenols and other homologues of phenol. The largest use for phenol-formaldehyde resins was in the manufacture of moulding powders, which were really mixtures of resins with various fillers. There were two main methods of manufacturing moulding powders. A resin dissolved in alcohol gave a thick viscose solution which could be incorporated or mixed with various filler materials such as wood flour. The wood-flour, wetted with varnish, together with other ingredients was spread on trays and dried in a vacuum oven to remove the spirit solvent. This was known as the wet method of manufacturing moulding powders. In the dry method the resin was ground up finely in a grinder or ball mill and mixed in a dry state with the filler, pigment or dyestuffs, etc. The dry materials intimately mixed were then compounded together in a machine. A one stage resin was a resin made with a basic catalyst which on the application of heat simply went further on its own through condensation stage to the polymerisation stage and did not stop until it reached its final finished condition. If an acid catalyst was used instead of a basic catalyst in the first reaction the resin formation went on to the condensation stage and then ceased. It was only polymerised to the final stage by the addition of further methylene groups in the presence of an alkaline reagent—the two step resin.

Speaking of phenol, cresols and xylenols, Mr. Dring said it was remakable that the first of the series was so uniquely desirable in the phenol-formaldehyde reaction. It might be thought that the greater complexity of the higher phenols would result in a moulding material of higher qualities than that from the simple phenol, but that was not borne out in practice. Resorcinol had given promise of producing an extraordinary material, but so far had not justified the high hopes which had been held of it some two or three years ago. It gave an exceedingly rapid moulding powder, but was really too rapid for the present day conception of moulding.

Letters to the Editor

The Editor welcomes expression of opinion and fact from responsible persons for publication in these columns. Signed letters are, of course, preferred, but where a desire for anonymity is indicated this will invariably be respected. From time to time letters containing useful ideas and suggestions have been received, signed with a nom-de-plume and giving no information as to their origin. Correspondence cannot be published in THE CHEMICAL AGE unless its authorship is revealed to the Editor.

Educated Unemployed

SIR,—In all large industrial districts there is a class of unemployed of whose existence the public is hardly aware. Although they receive no assistance from the State however desperate their case may be, it is only occasionally that their need is brought to the notice of the public, and the latter little realise either their numbers or the hardships which they suffer in silence. It was for the purpose of assisting this class—which is composed mainly of men with executive and administrative experience, engineers, chemists, accountants, and the "black-coated" worker generally—that the Britsh Executive Employment Society was formed by a group of men who were unemployed themselves.

Our aims which are set forth in a leaflet which can be obtained by anyone interested from the hon. secretary, 133 Oxford Street, London, W.1, are briefly (1) to put members into touch with any existing vacancies, and (2) to promote and undertake such activities as will create work—as we realise that there are not enough jobs to go round. One of the chief causes of deterioration of unemployed men being the loss of contact with active business and the inferiority complex arising from isolation, a clubroom has been opened where members can meet. An employment bureau is in operation and a number of men have been placed in suitable employment.

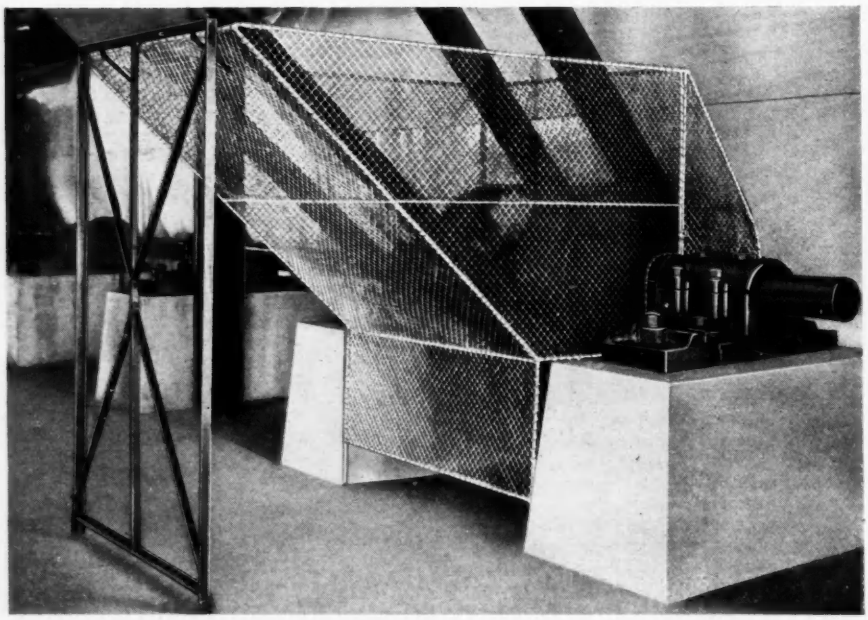
In order to provide funds for office expenses a business bureau has been started and is now in active operation. Arrangements are being made to start tourist camps in various parts of the country, to be run on lines similar to those which have proved so successful in Canada and the States. We have a number of other plans under consideration, but we are hampered by lack of funds, and we welcome the investigations of anyone who, interested in our aims, would care to support us in carrying them out. Any of your readers who would like to have further particulars of the society and its work, can obtain them by writing to the hon. secretary.—Yours faithfully,

RONALD OGDEN (chairman),
WALDO MAAS (vice-chairman).
British Executive Employment Society,
133 Oxford Street, London, W.1.

The Need for Efficient Machinery Guards

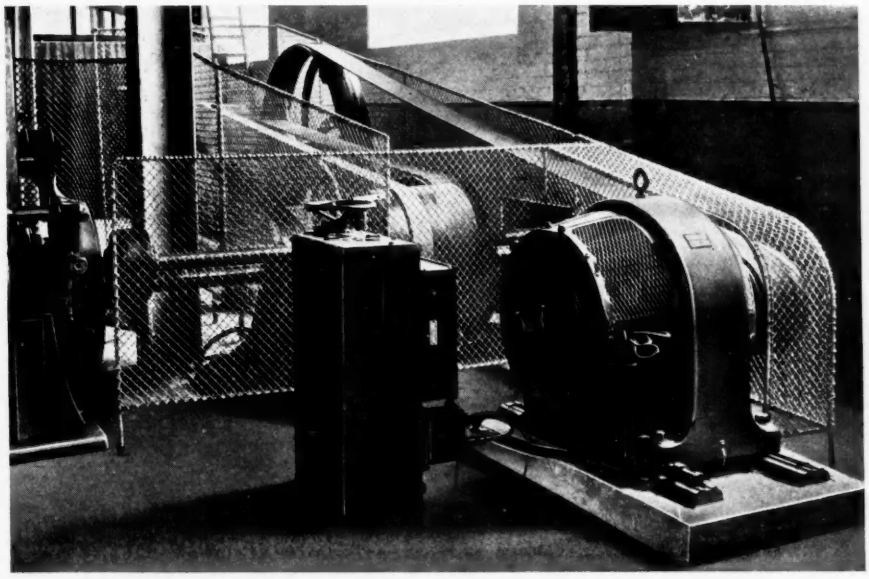
Wire Mesh and Perforated Metal

THE impulse to take an unnecessary risk occasionally dominates people. In effect the principle of "Safety First" is constantly affirmed, but like many other principles whose aim is for our benefit, it often fails to function or its guidance is frequently ignored precisely when it should be most implicitly obeyed. The average person is always liable to "chance it," unless restrained by something more tangible than a formula or a slogan. This is particularly the case with machinery in factories and workshops and, unless actually prevented by the most efficient type of machinery guard, accidents will inevitably happen. The factory owner is legally bound to make proper provision against accidents. He is also liable to heavy penalties if the safety devices applicable to the circumstances are found to be inadequate, and in addition substantial compensation has to be paid.



"Safety First" principles necessitated by Unusual Circumstances.

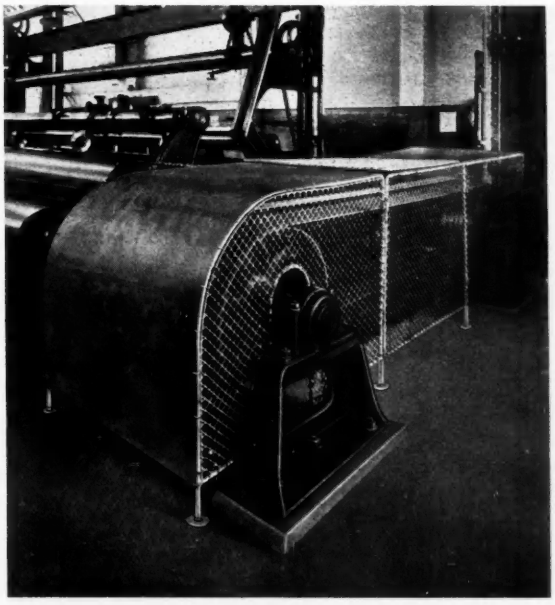
Apart from the legal obligation, however, the provision of effective machinery guards is the best method of insuring against accidents. The cost of such protection is almost negligible as compared with the liabilities arising from the lack of inadequate protection. Again, the smooth-running of



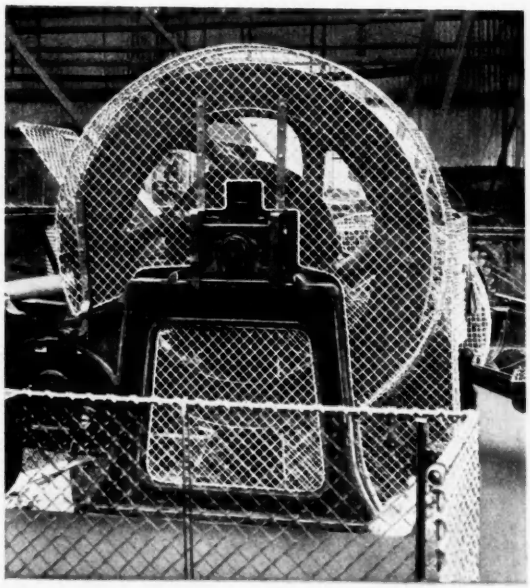
Diamond Mesh Wirework Guards applied for the Protection of Motor Pulley and Driving Belt.

a factory is disturbed by accidents, the moral effect of which merely from the point of view of self interest, can and should be prevented. Insurance companies have been known to increase their premiums in the case of factories where accidents frequently occur. It is, therefore, evident that legally, morally and from mere self-interest, the guarding of machinery should be totally removed from any perfunctory compliance with regulations. Unguarded driving belts or pulleys are always potential sources of danger. Yet we have seen machines that were otherwise adequately protected with belt and pulley left unguarded.

The most satisfactory and economical type of guard for machinery, belts or pulleys, is strong wire mesh on stout steel rod frames. Belts and pulleys are sometimes guarded by being "boarded in," but wood has the serious disadvantage of adding to the fire risk and inspection is not so easily



Another instance of Wirework adapted to Avoid Accidents.



A large Flywheel Adequately protected by Wirework Guards.

effected as with those of wire mesh. The accompanying illustrations show several well-made wire mesh guards of various types, manufactured by G. A. Harvey and Co. (London), Ltd., who specialise in this class of work. Wire mesh guards are also equally effective when applied to actual machine operation. Whilst affording adequate protection, they do not interfere with the efficient operation of the machine and have an advantage over the solid type of guard in that they enable the operator to see the work. In special circumstances, where the extreme limit of security is required or where a smarter appearance is desired, as in certain parts of an electric power station, an excellent alternative material for guards is provided by perforated metal, which is now obtainable in steel, brass or copper.

British Overseas Chemical Trade in May

Considerable Increase in Imports

EXPORTS of chemicals, drugs, dyes and colours during May amounted to a total of £1,502,956, being £151,107 lower than the figures for May, 1932. Imports totalling £842,409 were higher by £296,607, and re-exports totalling £38,189 were higher by £888 as compared with May, 1932.

	Quantities. Month ended May 31. 1932.	1933.	Value. Month ended May 31. 1932. £	1933. £
Imports				
Acetic Anhydride .. cwt.	803	621	2,364	1,626
Acid, Acetic ..	718 tons	16,539 cwts.	24,042	27,042
Acid, Tartaric, including Tartrates .. cwt.	1,941	2,777	6,999	9,892
Bleaching Materials ,,	5,714	5,192	7,886	5,463
Borax .. .. ,,	12,184	8,642	6,102	4,739
Calcium Carbide .. ,,	49,433	68,195	30,782	38,274
Coal Tar Products, not elsewhere specified value	—	—	492	6,318
Glycerine, Crude .. cwt.	—	2,554	—	2,903
Glycerine, Distilled ,,	687	250	1,173	407
Red Lead and Orange Lead cwt.	884	2,569	1,004	2,299
Phosphorus .. ,,	7,151	4,693	27,314	16,404
Kainite, etc. .. ,, cwt.	9,218	27,861	2,132	4,544
Potassium Nitrate (Saltpetre) .. .. ,,	10,115	12,899	7,609	10,701
Other Pottasium Compounds cwt.	24,915	43,257	23,239	37,972
Sodium Nitrate .. ,,	10,074	1,702	4,487	563
Other Sodium Compounds cwt.	23,303	22,182	15,766	18,014
Tartar, Cream of .. ,,	200	914	758	2,850
Zinc Oxide .. tons	2	24	56	442
Other Chemical Manufactures .. .. value	—	—	121,041	218,829
Quinine and Quinine Salts oz.	10	132,462	3	9,549
Bark Cinchona (Bark Peruvian, etc.) .. cwt.	804	559	3,888	2,729
Other Drugs .. value	—	—	71,877	123,571
Intermediate Coal Tar Products used in the Manufacture of Dyes cwt.	548	301	5,443	2,089
Alizarine and Alizarine Red .. .. cwt.	—	—	—	—
Indigo, Synthetic ,,	—	—	—	—
Finished Dyestuffs ,,	—	—	—	—
Other Finished Dyestuffs cwt.	3,210	4,303	91,865	101,571
Cutch .. .. ,,	1,810	3,906	1,749	3,875
Other Extracts for Dyeing cwt.	485	3,170	1,335	11,365
Indigo, Natural .. ,,	24	—	465	—
Extracts for Tanning (Solid or Liquid) .. cwt.	71,608	99,078	54,643	67,690
Barytes, Ground .. ,,	16,007	26,853	3,162	5,196
White Lead (Dry) ,,	1,738	7,728	2,437	9,307
Other painters' colours and materials .. cwt.	47,761	83,816	55,689	95,774
TOTAL .. value	—	—	545,802	842,409
Exports				
Acid, Sulphuric .. cwt.	3,250	8,002	2,273	2,762
Acid, Tartaric, including Tartrates .. cwt.	730	909	4,008	4,159
Ammonium Chloride (Muriate) .. .. tons	401	337	7,227	6,205
Ammonium Sulphate cwt.	47,841	25,904	241,260	151,478
Bleaching Powder (Chloride of Lime) .. cwt.	50,454	55,781	14,923	15,568
COAL TAR PRODUCTS—				
Anthracene .. cwt.	2	—	2	—
Benzol and Toluol gal.	260	176,934	31	17,380
Carbolic Acid (crude) ,,	8,781	5,614	852	643
Carbolic Acid (Crystals) cwt.	905	1,091	2,610	4,367
Cresylic Acid .. gal.	78,755	69,117	7,978	6,214
Naphtha .. ,,	7,875	5,590	447	459
Naphthalene (excluding Naphthalene Oil) cwt.	10,946	10,190	2,835	3,080
Tar Oil, Creosote Oil, etc. .. .. gal.	2,408,339	2,787,666	46,648	32,851
Other Sorts .. cwt.	47,684	19,354	14,258	9,536
COAL TAR PRODUCTS value	—	—	75,661	74,530
Copper, Sulphate of tons	5,185	2,700	87,143	38,078
Disinfectants, Insecticides, cwt.	26,720	25,895	63,230	55,104
Glycerine, Crude .. ,,	1,522	1,266	1,587	1,089
Glycerine, Distilled ,,	9,610	7,657	20,272	15,051
Potassium Chromate and Bichromate .. cwt.	1,638	1,168	4,174	2,852
Potassium Nitrate (Saltpetre) .. .. cwt.	1,833	1,853	2,834	3,101
Other Potassium Compounds .. .. cwt.	1,678	1,429	9,870	6,773
Sodium Carbonate, including Crystals, Ash and Bicarbonate .. cwt.	396,548	313,595	101,579	82,966
Caustic Soda .. ,,	244,433	189,927	150,589	118,847
Sodium Chromate and Bichromate .. cwt.	1,602	2,312	3,123	4,219
Sodium Sulphate, including Salt Cake .. cwt.	11,804	39,103	1,875	4,979
Other Sodium Compounds cwt.	95,825	119,395	79,584	79,714
Zinc Oxide .. tons	667	1,211	12,797	23,640
Other Chemical Manufactures .. .. value	—	—	221,161	292,500
Quinine and Quinine Salts oz.	155,230	115,145	15,900	11,383
Other Drugs .. value	—	—	230,300	207,740
Dyes and Dyestuffs (Coal Tar) .. .. cwt.	7,217	7,889	78,744	81,330
Other Dyestuffs .. ,,	11,185	15,671	11,086	14,284
Barytes, Ground .. cwt.	2,111	3,311	1,119	1,309
White Lead (Dry) ,,	2,456	2,344	4,361	4,062
Paints and colours in paste form .. .. cwt.	20,416	20,639	35,732	35,355
Paints and Enamels prepared .. .. cwt.	32,902	26,659	98,382	79,593
Other painters' colours and terials .. .. cwt.	41,860	57,532	73,269	84,159
TOTAL .. value	—	—	1,654,063	1,502,956
Re-Exports				
Acid, Tartaric, including Tartrates .. cwt.	18	41	121	182
Borax .. .. ,,	169	—	136	—
Coal Tar Products, not elsewhere specified value	—	—	6	3
Potassium Nitrate (Saltpetre) .. .. cwt.	86	65	172	104
Sodium Nitrate .. ,,	945	4,250	416	1,758
Tartar, Cream of .. ,,	63	224	341	877
Other Chemical Manufactures .. .. value	—	—	4,730	13,247
Quinine and Quinine Salts oz.	1,391	3,563	193	405
Bark Cinchona (Bark Peruvian, etc.) .. cwt.	211	296	2,117	2,684
Other Drugs .. value	—	—	18,455	16,789
Cutch .. .. cwt.	269	301	337	365
Other Extracts for Dyeing cwt.	37	109	179	472
Indigo, Natural .. ,,	—	2	—	47
Extracts for Tanning (Solid or Liquid) .. cwt.	332	677	302	509
Painters' colours and materials .. .. cwt.	354	240	984	699
TOTAL .. value	—	—	37,301	38,189

Kali-Chemie, A.G.

Reduced Sales of Potash and Rock Salt

THE report of the Kali-Chemie A.G., for 1932 announces a falling-off in the sales of both potash and rock salt. Compensation for these setbacks was, however, achieved by steady maintenance of business in the sulphuric acid, sodium sulphate, ammonium sulphate and mixed fertiliser departments. Great activity has been shown in the superphosphate and Rhenania phosphate plants. The annual turnover in mineral pigments has once again been increased, but the production of barium carbonate and sulphur has further declined. Among the activities of the companies in which Kali-Chemie A.G. is financially interested, mention may be made of the forthcoming starting-up of a new barium peroxide plant by the Peroxyd-Werk Siesel A.G.

Etablissements Kahlmann

Considerable Reductions in Net Profits

THIS French chemical combine announced a considerable reduction in net profit for 1932, the figure being 38.09 million francs as compared with 59.4 million francs for the previous year. But since the company succeeded in reducing the amount written off in connection with investments and subsidiary holdings from 32.58 to 8.66 million francs, ample funds were available for payment of the usual 8 per cent. dividend on the ordinary shares. The favourable result is stated to follow the introduction of new manufacturing lines. The reduction in the value and quantity of their products has therefore only amounted to 3 per cent. In spite of the reduced inland consumption for superphosphates, the Kuhlmann concern has been able to maintain its export figures and has even increased its sale of nitrogen and mixed fertilisers in the export market. A comparatively favourable start is reported for the present year, the net profit for the first quarter of 1933 being maintained at the previous year's level.

Wages in the Dyeing Industry

Proposed Application for Increase

THE executive committees of the trade unions in the bleaching dyeing, finishing and calico printing trades will meet at Bradford to-day (Saturday) to consider a recommendation from the executive of the federation of the unions concerned to apply to employers in the Allied Association of Bleachers, Dyers and Finishers, and also to non-affiliated firms, for an immediate increase in wages. It is proposed that the application shall be for an advance of 5s. per week of 48 hours for all male adult workers, and 3s. for all females over 18, with a proportionate advance for juvenile workers. The application is also intended to include a proposal for a minimum wage of 1s. an hour for all adult males and 8d. an hour for all females over 18.

Mr. Arthur Shaw, secretary of the federation, at a meeting of the federation executive at Pendleton on June 16, said they intended also to approach the employers on the question of working hours. The normal working week should be 48 hours, but it was difficult in the dyeing trade to adhere rigidly to that figure. There should be a strict limitation of overtime to a maximum of 54 hours' work in each week. The extra hours, they suggested, should be so spread over a five-day week that the maximum in any one day of that week would be 11 hours, but in a six-day week the maximum should be 10 hours between Monday and Friday and four hours on Saturday. The normal starting hour should be not earlier than 7.45 a.m.

About 80,000 operatives in Lancashire, Yorkshire, Cheshire, Derbyshire, and Scotland are affected by the proposals. The last wages adjustment for these trades was made in February, 1931, when the dyers' pay was fixed at £2 11s. 7d., but a sliding scale reduction brought this figure down to £2 4s. 5d. in April this year. The unions are now desirous of securing a minimum, below which no sliding scale arrangement shall apply.

Misleading Food Labels

Observations of the Birmingham City Analyst

THE result of the analysis of a number of foods is given in the quarterly report of the Birmingham City Analyst, Mr. H. H. Bagnall. In reference to a sample of black currant jam, labelled "lower fruit standard," it is said this is one of the two formulated by the Food Manufacturers' Federation, and indicates the presence of at least 20 per cent. of the fruit mentioned on the label. The federation also requires that the manufacturer using this designation shall describe such jam on the label by the name of the fruit, accompanied by the words "with other fruit juice" in letters of size equal to those used for the name of the fruit. In this case, although the fruit content was satisfactory, the words "with other fruit juice" were in very small type,thus constituting an infringement of the undertaking given to the federation. The latter was informed of the facts for consideration and for such action as they found to be desirable.

Samples of a vitamin beverage are stated in the report to have consisted of a brown, coarse powder, with an odour resembling cocoa. It was directed to be mixed for use with boiling water or milk. The ingredients were stated to be nuts, malt, etc., vitamins A, B and D, and the beverage was also described as rich in vitamins. Analysis showed that about 83 per cent. was cane sugar and the remainder mainly cocoa. Nuts and malt, if present at all, were in very small amounts. Vitamin A was tested for, but was entirely absent. Judging from the composition of the article, it was almost certain that vitamins B and D, if present at all, were in extremely minute quantities. The packers were communicated with and acquainted with the results of the analysis. They agreed to scrap all the leaflets and to remove all the remarks relating to vitamins. They stated the firm manufacturing the article for them had not kept to the original formula, and they sent a sample taken from stock alleged to be made for them by another firm, presumably to the correct formula.

The French Chemical Society

Its Tribute to Priestley

THE French Chemical Society this year has held its annual meeting in Paris. The French have a sense of imagination as well as a healthy laxity in observance of rule which other nations lack; also they are masters of the art of composing a meal. So it comes that, having decided to follow our example and celebrate the bicentenary of Priestley's birth—with full right of their own, as he was an adopted French citizen by vote of the National Convention at the time of the revolution—by invitation of the Council of the Society, Sir William Pope took the chair at the opening meeting, on June 15, while the president, Professor Matignon, delivered a lengthy address upon Priestley and his work. The French chemist comes to Paris *pour s'amuser*, therefore only two other official dishes were provided, the one a discourse by Professor Bölseken, of Delft, on June 16, on his boric acid work; the other, on June 17, a discourse by Professor Späth, of Vienna, on his synthetic studies of alkaloids. International solidarity was cemented by an exceptionally well staged dinner on the last evening. Here we cannot get half a dozen of our chemists to work together in their own interest; the French easily make chemists of four nations rub shoulders.

Professor Matignon agrees with our own recent witnesses in rating Priestley very high, justifying therefore the opinion to this effect already given by Berthelot, his distinguished predecessor at the College de France. Let us hope that the false impression created by his biographer Thorpe is now nullified. Priestley's relations with Lavoisier were not discussed, nor was any further light shed upon the mystery of Phlogiston: Priestley's views upon this subject still await proper interpretation. The years just before and just after Lavoisier's death, up to the time of Dumas, are in no wise properly set before us; now that historical studies are coming to the fore, it is much to be desired that the task were undertaken. The Chemical Society was represented at the meeting by its president, Professor G. T. Morgan. The two societies have always been in sympathy but the action taken in celebrating Priestley is the highest compliment English chemistry has yet received from our French colleagues.

News from the Allied Industries

Safety Glass

THE TRIPLEX SAFETY GLASS CO., LTD., states that it is now marketing for export a safety glass known as "Triplex Toughened," which can stand up to extreme climatic conditions without discolouration.

Iron and Steel

THE UNITED STEEL WORKS AT ESSEN is to pay a dividend of 3 per cent. for 1932. The total turnover was £2,216,00 (at par), and the net profit £271,000. In 1931 no dividend was paid.

UNDER THE SCHEME OF ARRANGEMENT adopted at the end of last year, the losses of the Ebbw Vale Steel Iron and Coal Co., and its subsidiaries for the nine months to December 31 last, amounting to £105,718, were dealt with. In respect of the three months ended March 31, however, there was a further debit of £33,847, which is carried forward. Trade depression throughout the world and the consequent general decline in coal consumption and restrictions imposed abroad upon imports of coal seriously affected the company's colliery operations during the past year. Several of the pits of the group remained closed. The blast furnaces and steel works were also out of operation, but the sheet mills continued to work, the installation of additional plant having benefited this section of the business.

Rubber

ACCORDING TO A MESSAGE FROM BATAVIA, the Governor of the Dutch East Indies, speaking in the People's Council on June 14, said that the possibility of realising some form of rubber restriction seemed greater than a year and a half ago, though the great remaining difficulty was how to include the native cultivator in an arrangement in a satisfactory manner. A fresh prospect for restriction had been opened up, he said, following the fact that interested circles now seemed convinced that an arrangement was preferable to maintaining the present situation.

A SCHEME FOR THE RECONSTRUCTION of the India Rubber Gutta Percha and Telegraph Works Co., Ltd., is understood to be in preparation, including the reorganisation and reduction of the share capital, and the provision of further working capital. Shareholders are advised to await the publication of the details of the scheme, which will be issued as soon as it has been drafted by the company's legal advisers. The company is one of the oldest firms in the rubber trade, being registered as Silver's India Rubber Works and Telegraph Cable Co., Ltd., in 1864. It holds practically all the share capital of Palmer Tyre, Ltd., and all the share capital of Jointless Rim, Ltd.

Beet Sugar

THIS MONTH'S ISSUE of the "Ministry of Labour Gazette" gives an account of the special steps taken by employment exchanges to provide workpeople with seasonal employment in the beet sugar industry. During the last three years some 30,000 vacancies have been filled through exchanges in all branches of the industry, including work on the cultivation of sugar-beet and the manufacture of sugar at the factories. The service provided by the Ministry has been progressively extended and improved as increased use has been made of the exchanges by growers, and those who have not already done so are invited to take advantage of the service by notifying their labour requirements to the exchanges.

Artificial Silk

THE VEREINIGTE GLANZSTOFF-FABRIKEN, after depreciation allowance of Rm.8,700,000 (Rm.1 equals about 1s. 4¾d. at the present rate of exchange) against Rm.6,6000,000 last year, reports a net loss for 1932 amounting to Rm.5,400,000, now carrying the total loss to Rm.10,100,000. At the meeting to be held on June 27 it will be proposed that Rm.10,100,000 out of the reserves of Rm.20,000,000 be applied to cover this loss, and that the balance of Rm.9,900,000 be transferred to a special reserve for writing down the portfolio. The total loss to be written down on the portfolio may amount to Rm.45,000,000, but the board prefers to postpone a definite reconstruction of the balance sheet until more exact information is available.

China Clay

ANOTHER UNPROFITABLE YEAR'S TRADING is reported by the directors of English China Clays, Ltd., due to the demand for china clay being considerably less than the capacity to supply, with the resulting competition in prices accentuated by the international action in the restriction of facilities for export trading enjoyed in more prosperous times. It will be recalled that the company amalgamated with Lovering China Clays, Ltd., and H. D. Pochin and Co., Ltd., under the style of "English Clays, Lovering, Pochin and Co., Ltd.," as from October 1 last, so that the profit and loss account covers a period of only nine months to September 30 last. In respect of that period there was a loss of £12,586. Against this has been transferred the contingency reserve of £30,000, which, in the opinion of the directors, is no longer required, as the company is not now directly carrying on trading operations. The credit balance brought forward from 1931 is £12,863 and, after writing off the loss and charging income-tax, the board have a balance of £24,877 available. Of this amount £20,951 is absorbed in paying the arrears of preference dividend for the year 1931 and £3,926 is carried forward.

Dr. Michael Polanyi

A Manchester University Chair

DR. MICHAEL POLANYI, M.D., Ph.D. (Budapest) has accepted a Chair of Physical Chemistry in the University of Manchester, and it is expected that he will commence his duties at the beginning of the session 1933-34. Dr. Polanyi, who is a Hungarian by birth, was educated at Budapest University and studied medicine there until 1913. He gained a scholarship for experimental work in biochemistry and also undertook studies in thermodynamics. On leaving Budapest he entered the Technical High School at Karlsruhe to study chemistry. In September, 1920, he was appointed assistant to Professor Herzog at the Kaiser-Wilhelm Institute for Textile Chemistry and there studied the structure of cellulose, devised a method for taking X-ray diagrams and worked on the plasticity and structure of solids, especially of metals

At the beginning of 1923 he became a Privatdozent at the Technical High School in Berlin. Six months later he transferred to the Kaiser Wilhelm Institute for Physical and Electro Chemistry, and there took up the experimental study of reaction Kinetics and the mechanism of chemical reactions. In 1926 he received the title of a Professor at the Technical High School of Berlin. Dr. Polanyi resigned his Berlin post last month as a protest against the Nazi treatment of Jewish and Liberal professors.

Controlling the Big Business

Danger of Statistics

A MANAGING director should not be called upon to spend his time finding out his position. That should be done for him by his assistants, and the results submitted to him ready for his policy decisions, said Mr. T. G. Rose at a British Data Service luncheon at the Holborn Restaurant, on June 14.

The problem of control was almost entirely a problem of how to arrange the vital facts and figures of a business in such a way that the man at the head could see clearly what was going on. The danger in un-co-ordinated masses of information and statistics was that one particularly striking item might be given an undue importance. It was precisely the difficulty of reducing the statistics of a business to some simple balanced form that had rendered it so arduous for the man at the head of affairs to obtain full value from the records placed before him. Higher control split the whole of the occurrences of an industrial undertaking into three divisions: the business position, the trading position, and the financial position. The principle underlying modern higher control was to segregate those occurrences in accordance with the management organisation, to demonstrate clearly by the use of the primary figures only, how they were affecting the well-being of the concern and so prevent the managing director from being swamped by minor details.

Inventions in the Chemical Industry

Specifications Accepted and Applications for Patents

THE following information is prepared from the Official Patents Journal. Printed copies of Specifications accepted may be obtained from the Patent Office, 25 Southampton Buildings, London, W.C.2, at 1s. each. The numbers given under "Applications for Patents" are for reference in all correspondence up to the acceptance of the Complete Specification.

Specifications Accepted with Date of Application

PREPARATION OF TITANIUM COMPOUNDS.—H. Spence, W. B. Llewellyn, and P. Spence & Sons, Ltd. Aug. 25, 1931. 393,264.

RECOVERY OF SULPHUR.—H. G. C. Fairweather, (R. F. Bacon). Aug. 28, 1931. 393,307.

PRODUCTION OF WATER-FREE ETHYL ALCOHOL.—Deutsche Gold- und Silber-Scheideanstalt Vorm. Roessler. Feb. 4, 1931. 393,265.

PRODUCTION OF WATER-FREE ETHYL ALCOHOL.—Deutsche Gold- und Silber-Scheideanstalt Vorm. Roessler. June 19, 1931. 393,266.

MANUFACTURE OF CONDENSATION PRODUCTS FROM ALIPHATIC ORGANIC COMPOUNDS.—British Industrial Solvents, Ltd., W. P. Joshua, H. M. Stanley, and J. B. Dymock. Oct. 26, 1931. 393,267.

MANUFACTURE OF INTERMEDIATE PRODUCTS AND DYESTUFFS THEREFROM.—A. G. Bloxam (Soc. of Chemical Industry in Basle). Nov. 17, 1931. 393,271.

PROCESS OF PREPARING FROM ROCK PHOSPHATE A FERTILISER SUITABLE FOR USE ON ACID OR LIME DEFICIENT SOILS OR ON SOILS RICH IN IRON.—A. B. Adams. Nov. 24, 1931. 393,300.

MANUFACTURE OF EMULSIONS, DISPERSIONS, AND THE LIKE.—Imperial Chemical Industries, Ltd., A. J. Hailwood, and W. Todd. Nov. 25, 1931. 393,276.

DYESTUFFS OF THE ANTHRAQUINONE SERIES.—Imperial Chemical Industries, Ltd., F. Lodge and C. H. Lumsden. Dec. 2, 1931. 393,316.

SEPARATION OF ETHYLENE FROM ITS HOMOLOGUES.—H. G. Watts and Imperial Chemical Industries, Ltd. Dec. 2, 1931. 393,317.

PROCESS FOR THE MANUFACTURE OF SULPHONIC ACIDS OF THE ANTHRAQUINONE SERIES.—A. Carpmael (I. G. Farbenindustrie). Dec. 8, 1931. 393,331.

PROCESS FOR IMPARTING A GLOBULAR SHAPE TO SALTS.—A. L. Mond (I. G. Farbenindustrie). Dec. 9, 1931. 393,332.

PRODUCTION OF PATTERN EFFECTS WITH VAT DYESTUFFS.—Bleachers' Association, Ltd., C. S. Parker, C. L. Wall and F. Farrington. March 3, 1932. 393,381.

PROCESS OF DYEING AND PRINTING.—I. G. Farbenindustrie. May 8, 1931. 393,408.

PRODUCTION OF POTASSIUM BICARBONATE AND/OR CARBONATE.—Kali-Chemie Akt.-Ges. Sept. 29, 1931. 393,437-8.

PIGMENTS.—Harshaw Chemical Co. May 23, 1932. 393,474.

MANUFACTURE OF SHAPED ARTICLES FOR POLYVINYL ALCOHOLS.—Consortium für Elektrochemische Industrie Ges. Nov. 16, 1931. 393,488.

PROCESS AND APPARATUS FOR THE CONTINUOUS MUTUAL REACTION OF LIQUIDS.—K. Schmid. Feb. 12, 1932. 393,527.

PRODUCTION AND REGENERATION OF SOLUTIONS OF FERRIC OXALATE.—Curtin-Howe Corporation. April 28, 1932. 393,531.

PROCESS FOR THE MANUFACTURE OF POTASSIUM BICARBONATE AND/OR CARBONATE.—Kali-Chemie Akt.-Ges. March 4, 1932. 393,534.

MANUFACTURE OF CHLOROSULPHONIC ACID AND SULPHUR DIOXIDE.—Soc. of Chemical Industry in Basle. Feb. 17, 1932. 393,546.

Complete Specifications Open to Public Inspection

PROCESS FOR PRODUCING PLASTIC MASSES FROM CARBAMIDE AND CARBAMIDE DERIVATIVES.—O. Neuss. Dec. 3, 1931. 32062/32.

PROCESS FOR THE MANUFACTURE OF SULPHURIC ACID DERIVATIVES OF FATTY ESTERS.—Henkel et Cie Ges. Dec. 5, 1931. 32855/32.

MANUFACTURE OF ESTERS SUBSTITUTED IN THE ACID RESIDUE.—Henkel et Cie Ges. Dec. 5, 1931. 33409/32.

ACTIVE CARBON.—Compagnie Française de Produits Organo-Chimiques. Dec. 4, 1931. 33778-9/32.

ORGANIC PRODUCTS AND PROCESSES OF MAKING THE SAME.—Mantle Lamp Co. of America. Nov. 30, 1931. 33904/32.

PROCESS FOR THE MANUFACTURE OF LAKES FROM BASIC DYESTUFFS. I. G. Farbenindustrie. Dec. 1, 1931. 33935/32.

PROCESS OF IMPROVING SHEETS AND FILMS OF COLLOIDS.—I. G. Farbenindustrie. Dec. 2, 1931. 34043/32.

MANUFACTURE OF VAT DYESTUFF PREPARATIONS.—W. W. Groves. Dec. 2, 1931. 34177/32.

PRODUCTION OF CELLULOSE DERIVATIVE MATERIALS.—British Celanese, Ltd. Dec. 3, 1931. 34390/32.

PROCESS FOR THE MANUFACTURE OF FATTY SUBSTANCES FOR THE TREATMENT OF HIDES.—Soc. Progil Soc. Anon. Dec. 5, 1931. 34444/32.

Applications for Patents

TREATMENT OF SULPHO-ALUMINIC MINERALS AND SALTS.—C. E. Bustos. June 9. 16596.

THERAPEUTIC SUBSTANCE.—F. Y. Chuck. June 7. (United States, July 19, '32.) 16399.

INSECTICIDE.—G. Clarkson. June 6. 16114.

MELTING AND PURIFYING MAGNESIUM.—Dow Chemical Co. June 8. (United States, Aug. 3, '32.) 16490.

PRODUCTION OF AZO DYESTUFFS.—E. I. Du Pont de Nemours and Co. June 8. (United States, June 9, '32.) 16457.

MANUFACTURE OF ARTIFICIAL LEATHER, ETC.—E. I. Du Pont de Nemours and Co. June 9. (United States, June 9, '32.) 16615.

MANUFACTURE OF ZINC CHLORIDE.—Grasselli Chemical Co.—June 8. (United States, June 9, '32.) 16456.

ALUMINIUM ALLOY.—H. C. Hall. June 7. 16354.

MANUFACTURE OF OXAZINE DYESTUFFS.—I. G. Farbenindustrie. June 6. (Germany, June 4, '32.) 16234.

MANUFACTURE OF DYESTUFFS.—I. G. Farbenindustrie. June 6. (Germany, June 6, '32.) 16280.

SENSITISING SILVER HALIDE EMULSION LAYERS.—I. G. Farbenindustrie. June 7. (Germany, June 7, '32.) 16363.

PRODUCTION OF POWDER FROM MAGNESIUM, ETC.—I. G. Farbenindustrie. June 7. (Germany, July 22, '32.) 16366.

MANUFACTURE OF IRON OXIDE PIGMENTS.—I. G. Farbenindustrie. June 8. (Germany, June 8, '32.) 16482.

MANUFACTURE OF AZO DYESTUFFS.—I. G. Farbenindustrie. June 8. (Germany, June 10, '32.) 16483.

MANUFACTURE OF AZO DYESTUFFS.—I. G. Farbenindustrie. June 8. (Germany, Sept. 28, '32.) 16484.

CHEMICAL COMPOUNDS FOR TREATING RUBBER, ETC.—Imperial Chemical Industries, Ltd. June 6. 16235.

LEATHER DYESTUFFS.—Imperial Chemical Industries, Ltd., M. Mendoza and F. L. Rose. June 6. 16236.

TOXIC DERIVATIVES.—Imperial Chemical Industries, Ltd. June 6. 16237.

JOINT MANUFACTURE OF SODIUM SULPHATE AND HYDROCHLORIC ACID.—Imperial Chemical Industries, Ltd. June 6. 16238.

ANTIFORMING AGENTS.—Imperial Chemical Industries, Ltd. June 7. 16408.

DYESTUFF INTERMEDIATES.—Imperial Chemical Industries, Ltd., M. Mendoza and F. L. Rose. June 7. 16409.

PRODUCTION OF CHLORINATED RUBBER PRODUCTS.—Imperial Chemical Industries, Ltd. June 8. 16497.

MANUFACTURE AND USE OF BLASTING EXPLOSIVES.—Imperial Chemical Industries, Ltd., and A. G. White. June 8. 16498.

BLASTING EXPLOSIVES.—Imperial Chemical Industries, Ltd., and A. G. White. June 9. 16590.

REVERSING ROTATION OF OPTICALLY-ACTIVE PHENYL ALKAMINES.—Legerlotz. June 9. (Germany, June 11, '32.) 16603.

JOINT MANUFACTURE OF SODIUM SULPHATE AND HYDROCHLORIC ACID.—F. D. Leicester. June 6. 16238.

REFINING MINERAL OIL, ETC.—M. B. Miller and Co. June 9. (United States, Dec. 22, '32.) 16584, 16585.

TREATMENT OF SULPHO-ALUMINIC MINERALS AND SALTS.—L. Nordenflycht. June 9. 16596.

MANUFACTURE OF VISCOSE ARTIFICIAL SILK.—North British Rayon, Ltd. June 7. 16398.

METHOD OF HYDROGEN ACTIVATION.—D. de Ros. June 7. 16364.

TREATMENT OF COAL TARS.—D. de Ros. June 7. 16365.

REFINING CRUDE COPPER.—Soc. d'Electrochimie, d'Electro-Métallurgie et des Aciéries Electriques d'Ugine. June 6. (Italy, June 6, '32.) 16273.

DEOXIDATION AND PURIFICATION OF COPPER.—Soc. d'Electrochimie, d'Electro-Métallurgie et des Aciéries Electriques d'Ugine. June 6. (Italy, June 6, '32.) 16274.

PRODUCTION OF CHLORINATED RUBBER PRODUCTS.—W. D. Spencer. June 8. 16497.

DEOXYGENATION OF ORGANIC COMPOUNDS.—M. Stuart. June 7. 16407.

PREPARATION FOR HARDENING, PRESERVING AND WATERPROOFING LEATHER.—S. Summerson. June 10. 16620.

CONTROLLING PROCESSES OF CONCENTRATION OF CRYSTALLISATION.—D. Teatini. June 8. (Belgium, June 9, '32.) 16499, 16500.

MAKING GRAPHITE LUBRICANTS.—W. C. Thorpe. June 6. 16224.

DEOXYGENATION OF ORGANIC COMPOUNDS.—A. G. L. Try. June 7. 16407.

MANUFACTURE OF DELUSTRED RAYON.—Viscose Co. June 9. (United States, Sept. 20, '32.) 16573.

MANUFACTURE OF SUBSTITUTED MALONIC ACIDS.—Dr. A. Wacker Ges. für Electrichemische Industrie Ges. June 8. (Germany, June 8, '32.) 16476.

MANUFACTURE OF VISCOSE ARTIFICIAL SILK.—E. Walls. June 7. 16398.

PREPARING PROTEIN EMULSIONS AND SUSPENSIONS.—V. G. Walsh. June 7. 16361.

JOINT MANUFACTURE OF SODIUM SULPHATE AND HYDROCHLORIC ACID.—J. A. Weil. June 6. 16238.

Weekly Prices of British Chemical Products

Review of Current Market Conditions

THE following market report is based on information supplied by the British manufacturers concerned, and unless otherwise qualified the figures quoted apply to fair quantities, net and naked at makers' works. Where no locality is indicated, the prices are general for the United Kingdom. Particulars of the London chemical market are specially supplied to THE CHEMICAL AGE by R. W. Greeff and Co., Ltd., and Chas. Page and Co., Ltd., and those of the Scottish chemical market by Chas. Tennant and Co., Ltd.

THE demand for chemical products continues fairly satisfactory with indications that buyers are prepared to book their forward requirements much more freely than has been the case of late. Prices on the whole remain extremely firm with little variation. Inquiry for naphthas and benzols is still good, and prices remain unchanged from last week. Marked firmness is a feature of most sections of the Manchester chemical market and during the past week values in several sections have moved up a little. Among sellers, however, the general experience is that business has made a slow start after the holidays, and, on the whole, bookings are not up to the aggregate of the weeks just before the stoppage. Delivery specifications against orders on the books are on a fairly satisfactory scale. A continued improvement has to be reported in the Scottish heavy chemical market.

General Chemicals

ACETONE.—LONDON: £65 to £68 per ton; SCOTLAND: £66 to £68 ex wharf, according to quantity.

ACID, ACETIC.—Tech. 80%, £38 5s. to £40 5s.; pure 80% £39 5s.; tech., 40%, £20 5s. to £21 15s.; tech., 60%, £28 10s. to £30 10s. LONDON: Tech., 80%, £38 5s. to £40 5s.; pure 80%, £39 5s. to £41 5s.; tech., 40%, £20 5s. to £22 5s.; tech., 60%, £29 5s. to £31 5s. SCOTLAND: Glacial 98/100%, £48 to £52; pure 80%, £39 5s.; tech. 80%, £38 5s. d/d buyers' premises Great Britain. MANCHESTER: 80%, commercial, £39; tech. glacial, £52.

ACID, BORIC.—SCOTLAND: Granulated commercial, £26 10s. per ton; B.P. crystals, £35 10s.; B.P. powder, £36 10s. in 1-cwt. bags d/d free Great Britain in 1-ton lots upwards.

ACID, CHROMIC.—11d. per lb., less 2½%, d/d U.K.

ACID, CITRIC.—LONDON: 9½d. per lb.; less 5%. MANCHESTER: 9½d.

ACID, CRESYLIC.—97/99%, 1s. 1d. to 1s. 7d. per gal.; 98/100%, 1s. 5d. to 2s.

ACID, FORMIC.—LONDON: £47 10s. per ton.

ACID, HYDROCHLORIC.—Spot, 3s. 9d. to 6s. carboy d/d according to purity, strength and locality. SCOTLAND: Arsenical quality, 4s.; dearsenicated, 5s. ex works, full wagon loads.

ACID, LACTIC.—LANCASHIRE: Dark tech., 50% by vol., £24 10s. per ton; 50% by weight, £28 10s.; 80% by weight, £48; pale tech., 50% by vol., £28; 50% by weight, £33; 80% by weight, £53; edible, 50% by vol., £41. One-ton lots ex works, barrels free.

ACID, NITRIC.—80° Tw. spot, £18 to £25 per ton makers' works, according to district and quality. SCOTLAND: 80°, £23 ex station full truck loads.

ACID, OXALIC.—LONDON: £47 7s. 6d. to £57 10s. per ton, according to packages and position. SCOTLAND: 98/100%, £49 to £52 ex store. MANCHESTER: £48 to £52 ex store.

ACID, SULPHURIC.—Average prices f.o.r. British makers' works, with slight variations owing to local considerations; 140° Tw. crude acid, £3 per ton; 168° Tw. arsenical £5 10s.; 168° Tw. non-arsenical, £6 15s. SCOTLAND: 144° quality, £3 12s. 6d.; 168°, £7; dearsenicated, 20s. per ton extra.

ACID, TARTARIC.—LONDON: 11½d. per lb. SCOTLAND: B.P. crystals, 10¾d., carriage paid. MANCHESTER: 1s.

ALUM.—SCOTLAND: Lump potash, £9 per ton ex store.

ALUMINA SULPHATE.—LONDON: £8 5s. to £9 10s. per ton. SCOTLAND: £8 to £8 10s. ex store.

AMMONIA, ANHYDROUS.—Spot, 10d. per lb. d/d in cylinders. SCOTLAND: 10d. to 1s. containers extra and returnable.

AMMONIA LIQUID.—SCOTLAND: 80°, 2½d. to 3d. per lb., d/d.

AMMONIUM BICHROMATE.—8d. per lb. d/d U.K.

AMMONIUM CARBONATE.—SCOTLAND: Lump, £32 per ton; powdered, £34, in 5-cwt. casks d/d buyers' premises U.K.

AMMONIUM CHLORIDE.—£37 to £45 per ton, carriage paid. LONDON: Fine white crystals, £19 to £20. (See also Salammoniac.)

AMMONIUM CHLORIDE (MURIATE).—SCOTLAND: British dog tooth crystals, £32 to £35 per ton carriage paid according to quantity. (See also Salammoniac.)

ANTIMONY OXIDE.—SCOTLAND: Spot, £24 per ton, c.i.f. U.K. ports.

ANTIMONY SULPHIDE.—Golden 6½d. to 1s. 1½d. per lb.; crimson, 1s. 3d. to 1s. 5d. per lb., according to quality.

ARSENIC.—LONDON: £19 c.i.f. main U.K. ports for imported material; Cornish nominal, £23 f.o.r mines. SCOTLAND: White powdered, £24 ex wharf. MANCHESTER: White powdered Cornish, £23 at mines.

ARSENIC SULPHIDE.—Yellow, 1s. 5d. to 1s. 7d. per lb.

BARIUM CHLORIDE.—£11 per ton.

BISULPHITE OF LIME.—£6 10s. per ton f.o.r. London.

BLEACHING POWDER.—Spot 35/37% £7 19s. per ton d/d station in casks, special terms for contract. SCOTLAND: £8 15s. in 5/6 cwt. casks.

BORAX, COMMERCIAL.—Granulated, £15 10s. per ton; powder, £17 packed in 1-cwt. bags, carriage paid any station Great Britain. Prices are for 1-ton lots and upwards.

CADMIUM SULPHIDE.—2s. 10d. to 3s. 2d.

CALCIUM CHLORIDE.—Solid 70/75% spot, £5 5s. per ton d/d station in drums.

CARBON BISULPHIDE.—£30 to £32 per ton, drums extra.

CARBON BLACK.—3½d. to 5d. per lb., ex wharf.

CARBON TETRACHLORIDE.—£41 to £46 per ton, drums extra.

CHROMIUM OXIDE.—10d. to 10½d. per lb., according to quantity d/d U.K. Green, 1s. 2d. per lb.

CHROMETAN.—Crystals, 3½d. per lb. Liquor, £19 10s. per ton d/d

COPPERAS (GREEN).—SCOTLAND: £3 15s. per ton, f.o.r. or ex works.

CREAM OF TARTAR.—LONDON: £4 per cwt.

DIPHENYLGUANIDINE.—2s. 2d. per lb.

FORMALDEHYDE.—LONDON: £28 per ton. SCOTLAND: 40%, £28 ex store.

LAMPBLACK.—£45 to £48 per ton.

LEAD ACETATE.—LONDON: White, £34 per ton; brown, £1 per ton less. SCOTLAND: White crystals, £34 to £36; brown, £1 per ton less. MANCHESTER: White, £31 10s.; brown, £29.

LEAD NITRATE.—£28 per ton.

LEAD, RED.—SCOTLAND: £27 per ton d/d buyer's works.

LEAD, WHITE.—SCOTLAND: £39 per ton, carriage paid.

LITHOPONE.—30%, £17 10s. to £18 per ton.

MAGNESITE.—SCOTLAND: Ground Calcined £9 per ton ex store.

METHYLATED SPIRIT.—61 O.P. Industrial 1s. 8d. to 2s. 3d. per gal. Pyridinised Industrial, 1s. 10d. to 2s. 5d. Mineralised, 2s. 9d. to 3s. 3d. 64 O.P. 1d. extra in all cases. Prices according to quantities. SCOTLAND: Industrial 64 O.P., 1s. 9d. to 2s. 4d.

NICKEL AMMONIUM SULPHATE.—£49 per ton d/d.

NICKEL SULPHATE.—£49 per ton d/d.

PHENOL.—9d. to 10d. per lb. nominal.

POTASH, CAUSTIC.—LONDON: £42. MANCHESTER: £40 to £41.

POTASSIUM BICHROMATE.—Crystals and Granular, 5d. per lb. net d/d U.K. Discount according to quantity. Ground 5¾d. LONDON: 5d. per lb. with usual discounts for contracts. SCOTLAND: 5d. d/d U.K. or c.i.f. Irish Ports. MANCHESTER: 5d.

POTASSIUM CHLORATE.—LONDON: £37 to £40 per ton. SCOTLAND: 99½/100% powder, £37. MANCHESTER: £38.

POTASSIUM CHROMATE.—6½d. per lb. d/d U.K.

POTASSIUM NITRATE.—SCOTLAND: Refined Granulated £29 per ton c.i.f. U.K. ports. Spot, £30 per ton ex store.

POTASSIUM PERMANGANATE.—LONDON: 8½d. per lb. SCOTLAND: B.P. crystals, 9d. MANCHESTER: Commercial, 8¼d. B.P., 8¾d.

POTASSIUM PRUSSIATE.—LONDON: 8½d. to 9d. per lb. SCOTLAND: Yellow spot material, 8½d. ex store. MANCHESTER: Yellow, 8½d.

SALAMMONIAC.—First lump spot, £42 17s. 6d. per ton d/d in barrels.

SODA ASH.—58% spot, £5 17s. 6d. per ton f.o.r. in bags, special terms for contracts.

SODA, CAUSTIC.—Solid 76/77° spot, £14 5s. per ton d/d station. SCOTLAND: Powdered 98/99%, £17 10s. in drums, £18 15s. in casks, Solid 76/77%, £14 10s. in drums; 70/73%, £14 12s. 6d., carriage paid buyer's station, minimum 4-ton lots; contracts 10s. per ton less. MANCHESTER: £13 5s. to £14 10s. contracts.

SODA CRYSTALS.—Spot, £5 to £5 5s. per ton d/d station or ex depot in 2-cwt. bags.

SODIUM ACETATE.—£22 per ton. LONDON: £23.

SODIUM BICARBONATE.—Refined spot, £10 10s. per ton d/d station in bags. SCOTLAND: Refined recrystallised £10 10s. ex quay or station. MANCHESTER: £10 10s.

SODIUM BICHROMATE.—Crystals cake and powder 4d. per lb. net d/d U.K. discount according to quantity. Anhydrous, 5d. per lb. LONDON: 4d. per lb. with discounts for quantities. SCOTLAND: 4d. delivered buyer's premises with concession for contracts. MANCHESTER: 4d. less 1 to 3½% contracts, 4d. spot lots.

SODIUM BISULPHITE POWDER.—60/62%, £16 10s. per ton d/d 1-cwt. iron drums for home trade.

SODIUM CARBONATE (SODA CRYSTALS).—SCOTLAND: £5 to £5 5s. per ton ex quay or station. Powdered or pea quality 7s. 6d. per ton extra. Light Soda Ash £7 ex quay, min. 4-ton lots with reductions for contracts.

SODIUM CHLORATE.—£32 per ton.

SODIUM CHROMATE.—3¾d. per lb. d/d U.K.
SODIUM HYPOSULPHITE.—SCOTLAND: Large crystals English manufacture, £9 5s. per ton ex stations, min. 4-ton lots. Pea crystals, £15 ex station, 4-ton lots. MANCHESTER: Commercial, £9 5s.; photographic, £15.
SODIUM NITRATE.—LONDON: Spot, £18 to £20 per ton d/d station in drums.
SODIUM PERBORATE.—LONDON: 10d. per lb.
SODIUM PHOSPHATE.—£12 10s. per ton.
SODIUM PRUSSIATE.—LONDON: 5d. to 5½d. per lb. SCOTLAND: 5d. to 5¾d. ex store. MANCHESTER: 4¾d. to 5¾d.
SODIUM SILICATE.—140° Tw. Spot £8 5s. per ton d/d station, returnable drums.
SODIUM SULPHATE (GLAUBER SALTS).—£4 2s. 6d. per ton d/d. SCOTLAND: English material £3 15s.
SODIUM SULPHATE (SALT CAKE).—Unground Spot, £3 15s. per ton d/d station in bulk. SCOTLAND: Ground quality, £3 5s. per ton d/d. MANCHESTER: £3 5s.
SODIUM SULPHIDE.—Solid 60/62% Spot, £10 15s. per ton d/d in drums; crystals 30/32%, £8 per ton d/d in casks. SCOTLAND: For home consumption, Solid 60/62%, £10 5s.; broken 60/62%, £11 5s.; crystals, 30/32%, £8 2s. 6d. d/d buyer's works on contract, min. 4-ton lots. Spot solid 5s. per ton extra. Crystals, 2s. 6d. per ton extra. MANCHESTER: Concentrated solid, 60/62%, £11; commercial, £8.
SODIUM SULPHITE.—Pea crystals spot, £13 10s. per ton d/d station in kegs. Commercial spot, £9 10s. d/d station in bags.
SULPHATE OF COPPER.—MANCHESTER: £16 10s. to £17 per ton f.o.b.
SULPHUR.—£11 15s. per ton. SCOTLAND: Flowers, £11; roll, £10 10s.; rock, £9; ground American, £10 ex store.
SULPHUR CHLORIDE.—5d. to 7d. per lb., according to quality.
SULPHUR PRECIP.—B.P. £55 to £60 per ton according to quantity. Commercial, £50 to £55.
VERMILION.—Pale or deep, 4s. 4d. to 4s. 6d. per lb.
ZINC CHLORIDE.—SCOTLAND: British material, 98%, £18 10s. per ton f.o.b. U.K. ports.
ZINC SULPHATE.—LONDON AND SCOTLAND: £12 per ton.
ZINC SULPHIDE.—11d. to 1s. per lb.

Pharmaceutical and Fine Chemicals

ACID, CITRIC.—9¼d. per lb.
ACID, TARTARIC.—11¾d. per lb., less 5%.
CADMIUM IODIDE.—14s. 6d. per lb.
IRON QUININE CITRATE.—9¾d. to 1s. 0¼d. per oz.
LINALOL (ex Shui oil).—5s. 9d. per lb.
MENTHOL.—A.B.R. recryst., B.P., 15s. per lb.; synthetic detached crystals, 8s. 6d. to 10s. 6d. per lb.
PHENACETIN.—4s. to 4s. 6d. per lb.
POTASSIUM BITARTRATE, 99/100% (Cream of tartar).—£4 per cwt.
SODIUM BARBITONUM.—13s. to 15s. per lb.
SODIUM POTASSIUM TARTRATE (Rochelle sale).—£3 10s. per cwt.
TARTAR EMETIC, B.P.—3s. 9d. to 4s. 6d. per lb.

Essential Oils

ALMOND, FOREIGN, S.P.A.—9s. per lb.
BERGAMOT.—6s. 6d. per lb.
BOURBON GERANIUM.—25s. 3d. per lb.
CAMPHOR.—Brown, £4 per cwt.; white, £4 5s. per cwt.
CINNAMON.—3s. 6d. per lb.
CITRONELLA, JAVA.—2s. 9d. per lb.; Ceylon, 2s. 3d. per lb.
CLOVE.—90/92% English.—4s. 9d. per lb.
LAVENDER, MONT BLANC, 38/40%.—10s. per lb.
LEMONGRASS.—3s. per lb.
PEPPERMINT, JAPANESE.—6s. 6d. per lb.
SANDALWOOD, AUSTRALIAN, B.P. and French Codex, 92/95%, 15s. 6d. per lb.

Intermediates and Dyes

IN the following list of intermediates delivered prices include packages except where otherwise stated:—
ACID, BENZOIC, 1914 B.P. (ex Toluol).—1s. 9½d. per lb.
ACID, GAMMA.—Spot, 4s. per lb. 100% d/d buyer's works.
ACID, H.—Spot, 2s. 4½d. per lb. 100% d/d buyer's works.
ACID, NEVILLE AND WINTHER.—Spot, 3s. per lb. 100% d/d buyer's works.
ACID, SULPHANILIC.—Spot, 8d. per lb. 100% d/d buyer's works.
ANILINE OIL.—Spot, 8d. per lb., drums extra, d/d buyer's works.
ANILINE SALTS.—Spot, 8d. per lb. d/d buyer's works, casks free.
BENZALDEHYDE.—Spot, 1s. 8d. per lb., packages extra.
BENZIDINE BASE.—Spot, 2s. 5d. per lb. 100% d/d buyer's works.
p-CRESOL 34-5° C.—1s. 9d. per lb. in ton lots.
m-CRESOL 98/100%.—2s. 3d. per lb. in ton lots.
DICHLORANILINE.—2s. 3d. per lb.
DIMETHYLANILINE.—Spot, 1s. 6d. per lb., package extra.
DINITROBENZENE.—8d. per lb.
DINITROTOLUENE.—48/50° C., 8d. per lb.; 66/68° C. 8¾d. per lb.
DIPHENYLAMINE.—Spot, 2s. per lb., d/d buyer's works.
α-NAPHTHOL.—Spot, 2s. 4d. per lb., d/d buyer's works.
β-NAPHTHOL.—Spot, £78 15s. per ton in paper bags; £79 15s. in casks, in 1-ton lots.
α-NAPHTHYLAMINE.—Spot, 11½d. per lb., d/d buyer's works.
β-NAPHTHYLAMINE.—Spot, 2s. 9d. per lb. d/d buyer's works.
o-NITRANILINE.—5s. 10d. per lb.
m-NITRANILINE.—Spot, 2s. 7d. per lb. d/d buyer's works.
p-NITRANILINE.—Spot, 1s. 8d. per lb. d/d buyer's works.
NITROBENZENE.—Spot, 4½d. per lb.; 5-cwt. lots, drums extra.
NITRONAPHTHALENE.—9d. per lb.
SODIUM NAPHTHIONATE.—Spot, 1s. 9d. per lb.
o-TOLUIDINE.—Spot, 9½d. per lb., drums extra, d/d buyer's works.
p-TOLUIDINE.—Spot, 1s. 11d. per lb., d/d buyer's works.
m-XYLIDINE ACETATE.—3s. 4d. per lb.

Coal Tar Products

ACID, CARBOLIC.—Crystals, 9d. to 10d. per lb.; crude, 60's, 2s. 5d. to 2s. 6d. per gal.; 2% water 3s. 0¾d. MANCHESTER: Crystals, 9½d. per lb.; crude, 2s. 7d. per gal. SCOTLAND: 60's, 1s. 7d. to 1s. 8d.
ACID, CRESYLIC.—99/100%, 11d. to 1s. 8d. per gal.; pale 95%, 11d. to 11½d.; dark, 10d., all according to specification; refined, 1s. 7d. to 1s. 8d. LONDON: 98/100%, 1s. 3d.; dark, 95/97%, 11d. SCOTLAND: Pale 99/100%, 1s. 3d. to 1s. 4d.; 97/99%, 1s. to 1s. 1d.; dark 97/99%, 11d. to 1s.; high boiling acid, 2s. 6d. to 3s.
ANTHRACENE OIL.—Strained, 4½d. per gal.
BENZOL.—At works, crude, 9d. to 9½d. per gal.; standard motor 1s. 4d. to 1s. 4½d.; 90%, 1s. 5d. to 1s. 6d.; pure, 1s. 7½d. to 1s. 8d. LONDON: Motor, 1s. 7½d. SCOTLAND: Motor, 1s. 6½d. to 1s. 7½d.; 90%, 2s. 0½d. to 2s. 1½d.
CREOSOTE.—B.S.I. Specification standard, 3d. per gal. f.o.r. Home, 3¾d. d/d. LONDON: 3d. to 3½d. f.o.r. North; 4d. to 4½d. London. MANCHESTER: 2d. to 3½d. SCOTLAND: Specification oils, 3½d. to 4d.; washed oil, 3½d. to 4d.; light, 3d. to 3½d.; heavy, 4½d. to 5d.
NAPHTHA.—Solvent, 90/160%, 1s. 4d. to 1s. 5d. per gal.; 95/160%, 1s. 7d.; 90/190%, 9d. to 1s. 1d. LONDON: Solvent, 1s. 3½d. to 1s. 4d.; heavy, 11d. to 1s. 0½d. f.o.r. SCOTLAND: 90/160%, 1s. 3d. to 1s. 3½d.; 90/190%, 11d. to 1s. 2d.
NAPHTHALENE.—Crude, Hot-Pressed, £6 1s. 3d. per ton. Flaked, £10 per ton. Purified crystals, £9 10s. per ton in bags. LONDON: Fire lighter quality, £3 to £3 10s.; 74/76 quality, £4 to £4 10s.; 76/78 quality, £5 10s. to £6. SCOTLAND: 40s. to 50s.; whizzed, 65s. to 70s.
PITCH.—Medium soft, £4 5s. per ton. MANCHESTER: £3 15s. f.o.b. LONDON: £4 to £4 2s. 6d. f.o.b. East Coast part.
PYRIDINE.—90/140, 3s. 9d. to 4s. 6d. per gal.; 90/180, 2s. to 2s. 6d. SCOTLAND: 90/160% 4s. to 5s.; 90/220%, 3s. to 4s.
REFINED COAL TAR.—SCOTLAND: 4d. per gal.
XYLOL.—Common, 1s. 10d. to 1s. 11d. per gal.; pure, 2s. 1d. to 2s. 2d.
TOLUOL.—90%, 2s. to 2s. 1d. per gal.; pure, 2s. 4d.

Wood Distillation Products

ACETATE OF LIME.—Brown, £8 15s. to £9 per ton. Grey £14 to £15. Liquor, brown, 30° Tw., 6d. per gal. MANCHESTER: Brown, £9 10s.; grey, £15 10s. to £16.
ACETIC ACID, TECHNICAL, 40%.—£17 to £18 per ton.
AMYL ACETATE, TECHNICAL.—95s. to 110s. per cwt.
CHARCOAL.—£6 to £11 per ton.
WOOD CREOSOTE.—6d. to 2s. per gal., unrefined.
WOOD NAPHTHA, MISCIBLE.—2s. 7d. to 4s. per gal. Solvent, 3s. 9d. to 4s. 9d. per gal.
WOOD TAR.—£2 to £6 per ton.

Nitrogen Fertilisers

SULPHATE OF AMMONIA.—Export, £6 per ton f.o.b. U.K. ports in single bags; home, £6 10s. per ton, delivered in 6-ton lots to consumer's nearest station.
NITRATE OF SODA.—£8 16s. per ton, delivered in 6-ton lots to consumer's nearest station.
CYANAMIDE.—£7 per ton, delivered in 6-ton lots to consumer's nearest station.
NITRO-CHALK.—£7 5s. per ton, delivered in 6-ton lots to consumer's nearest station.
CONCENTRATED COMPLETE FERTILISERS.—£10 9s. 6d. to £11 per ton according to percentage of constituents.

Latest Oil Prices

LONDON, June 31.—LINSEED OIL was quiet. Spot, small quantities, £22 15s.; July, £19 17s. 6d.; July-Aug., £19 17s. 6d.; Sept.-Dec., £20 5s. per ton, naked. RAPE OIL was quiet. Crude extracted, £29; technical refined, £30 10s. per ton, naked, ex wharf. COTTON OIL was steady. Egyptian crude, £21; refined common edible, £23 10s.; and deadorised, £25 10s. per ton, naked, ex mill. TURPENTINE was quiet and lower. American, spot, 55s. 9d. per cwt.
HULL.—LINSEED OIL, spot, quoted £20 2s. 6d. per ton; June, £19 12s. 6d.; July-Aug., £20; Sept.-Dec., £20 5s. COTTON OIL, Egyptian, crude, spot, £20 10s.; edible, refined, spot, £23; technical, spot, £23; deodorised, £25, naked. PALM KERNEL OIL, crude, f.m.q., spot, £20 naked. GROUNDNUT OIL, extracted, spot, £24 10s.; deodorised, £28 10s. RAPE OIL, extracted, spot, £27 10s.; refined, £29. SOYA OIL, etracted, spot, £22; deodorised, £25 per ton. COD OIL, Sept., 17s. 6d. per cwt. CASTOR OIL, pharmaceutical, spot, 39s.; first, 34s.; second, 31s. per cwt. TURPENTINE, American, spot, 57s. 3d. per cwt.

Company News

British Drug Houses, Ltd.—The usual quarterly dividend of 1¼ per cent. is announced on the preference shares, payable on June 30.

Amalgamated Metal Corporation.—The usual half-yearly dividend on the 6 per cent. preference shares has been declared payable on July 1.

Tarmac, Ltd.—The dividend on the 5½ per cent. (free of tax) cumulative preference shares in respect of the half-year ending June 30, 1933, will be paid on July 1.

United Indigo and Chemical Co., Ltd.—A dividend at the rate of 5 per cent. per annum, subject to income tax at 5s. in the £ has been declared for the six months ending June 30 in respect of the preference shares.

Alliance Artificial Silk, Ltd.—It is announced that an issue of 300,000 6 per cent. participating preferred ordinary shares of £1 at par is to be made to persons registered on May 11, in the proportion of one share for each twenty shares in the original capital held.

Wm. Cory & Son, Ltd.—The net profit for the year ended March 31 last, after charging all expenses and cost of maintenance and making provision for depreciation was £654,494. The transfer to reserve is raised from £50,000 to £100,000, and the balance forward from £742,425, to £765,541. The annual general meeting will be held at Southern House, London, on June 27, at 11.30 a.m.

Ely Beet Sugar Factory.—The report for the year ended March 31 last states that after providing for all charges for income tax and for depreciation on capital assets, and after transferring £45,971 to general reserve, there is a balance of net profit of £45,000. The directors propose to apply this to a dividend on the ordinary shares of 10 per cent., free of tax.

Ipswich Beet Sugar Factory.—The report for the year ended March 31 last states that after providing for all charges, for income-tax and for depreciation on capital assets, and after transferring £14,386 to general reserve, there is a balance of net profit of £24,000. The directors propose to apply this to a dividend on the ordinary shares of 6 per cent. free of tax.

Aberthaw and Bristol Channel Portland Cement.—The balance brought forward was £72,738, to which is added the trading profit for the year to March 31, 1933, including interest and transfer fees, £47,164, making £119,902. The directors recommend a final dividend of 2½ per cent. on the ordinary shares, making 5 per cent. for the year, leaving to be carried forward £68,152. The annual general meeting will be held at Merthyr House, Cardiff, on June 26, at 3 p.m.

King's Lynn Beet Sugar Factory.—For the year ended March 31 last, the report states that after providing for all charges, for income-tax and for depreciation on capital assets, after writing off the deficiency brought forward of £14,659, and after transferring £23,866 to general reserve, there is a balance of net profit of £13,500. The directors propose to apply this to a dividend on the ordinary shares of 3 per cent., free of tax.

Forster's Glass Co.—The trading profit for the year ended March 31 last, after charging £12,745 for depreciation, was £44,930, to which is added the balance brought forward of £7,076, making £52,006. The directors recommend a dividend of 5 per cent. per annum, less tax, on the ordinary shares for the year, £10,000 be placed to reserve, and that £9,866 be carried forward.

Electric Furnace Co., Ltd.—For the year ended March 31, 1933, there is a net profit of £5,920 and £1,154 was brought forward, making a total available profit of £7,075. There has been paid an interim dividend of 3½ per cent. on the cumulative preferred ordinary shares amounting to £2,807, and the directors now recommend the payment of a final dividend of 3½ per cent. on the cumulative preferred ordinary shares, absorbing £2,878, leaving to be carried forward £1,389.

New Chemical Trade Marks

Compiled from official sources by Gee and Co., Patent and Trade Mark Agents, Staple House, 51 and 52 Chancery Lane, London, W.C.2.

Opposition to the Registration of the following trade marks can be lodged up to July 7, 1933.

Cibanite. 539,864. Class 1 and **Cibanoid.** 539,866. Class 1. Chemical substances used in manufactures, photography or philosophical research and anti-corrosives. Society of Chemical Industry in Basle, 141-227 Klybeckstrasse, Basle, Switzerland. March 13, 1933.

Tannafax. 541,188. Class 3. Chemical substances prepared for use in medicine and pharmacy. The Wellcome Foundation, Ltd., 67 Holborn Viaduct, London, E.C.1. May 3, 1933.

Chemical Trade Inquiries

The following trade inquiries are abstracted from the "Board of Trade Journal." Names and addresses may be obtained from the Department of Overseas Trade (Development and Intelligence), 35 Old Queen Street, London, S.W.1 (quote reference number).

Australia.—H.M. Trade Commissioner at Melbourne reports that the Melbourne City Council is calling for tenders, to be presented in Melbourne by August 14, 1933, for the supply of: 14,000 yards of 4-way glazed stoneware conduit; 52,000 yards of 4 in. fibre conduit. (Ref. B.Y. 7595.)

Mexico.—An individual in Mexico City desires to represent United Kingdom manufacturers of aniline colours and chemical products used in the textile, tanning, rubber, match and soap industries. Ref. No. 879.)

Norway.—An agent established at Bergen wishes to obtain the representation, on a commission basis, of United Kingdom exporters of sugar, feeding stuffs, fats, oils, etc. (Ref. No. 867.)

South Africa.—A manufacturers' representative at Cape Town, who is at present in the United Kingdom, desires to secure the representation of United Kingdom manufacturers of aniline dyes for the Cape Province. (Ref. No. 860.)

New Companies Registered

Ceebee, Ltd., 28 Buckingham Gate, Westminster, S.W.1. Registered June 6. Nominal capital £2,000 in £1 shares. Manufacturers of or dealers in chemical, refining, grinding and pulverising plant, and the products thereof, producers and manufacturers of and dealers in minerals, vegetable gums, chemicals and fabrics, etc. Directors: O. L. Swaebe, 17 South Street, Mayfair, W.1., P. H. Head, E. J. Evershed.

Chemicals Trading Co., Ltd., 46-7 London Wall, E.C.2. Registered June 7. Nominal capital £10,000 in £1 shares. Manufacturers or merchants of chemicals and manures, distillers, dye makers, metallurgists, etc. Directors: G. Hamilton, Castle House, Parkhill, Bexley; M. J. Lucey.

Eastern Counties Laboratories, Ltd., Atlas Buildings, Lloyds Avenue, Ipswich. Registered June 6. Nominal capital £1,000 in £1 shares. To adopt an agreement with G. M. Oxborrow and N. Stanley, and to carry on in Ipswich the business of analysts, analytical chemists, etc. Directors: N. Stanley, Culpho Manor, Ipswich, G. L. Ransome.

John Goudie, Ltd., 21 Leadenhall Street, E.C.3. Registered June 14. Nominal capital £100 in £1 shares. Manufacturers and refiners of and dealers in all kinds of oils and other oleaginous and saponaceous substances, etc. Directors: A. J. M. Duncan, 44 Queens Gate Gardens, S.W.; J. I. Pickering.

Horden, Sampson, Ltd. Registered June 10. Nominal capital £2,000 in 1,500 5 per cent. cumulative participating preference shares of £1 and 1,000 ordinary shares of 10s. each. Manufacturers and marketers of solvent products, etc. Directors: F. E. Horden, Overseas Club, St. James' Street, Park Place, S.W.1., A. E. R. Sampson.

Kirk, Hancock, Ltd. Registered June 12. Nominal capital £1,000 in £1 shares. Manufacturing, analytical, pharmaceutical and general chemists. Directors: G. A. Hancock, 68 Archer Lane, Sheffield; H. Kirk, 8 Hurley Drive, Wollaton Park, Nottingham.

Chas. Lowe & Co. (Montevideo), Ltd. Registered June 14. Nominal capital £300 in £1 shares. Manufacturers of and dealers in soap, glycerine, oils, tallow, colours, etc. A subscriber: G. G. Kershaw, 31 Booth Street, Manchester: A. Wrigley.

Metal Penetrations, Ltd., 17 Coleman Street, E.C.2. Registered June 2. Nominal capital £1,000 in £1 shares. Metallurgists, chemists, manufacturers of and dealers in metal alloys and ores, galvanizers, platers, etc. Directors: A. H. Kempton, 19 Arthur Road, Wimbledon, S.W.; Wm. E. Holland.

New Phoenix Dyeing Co., Ltd., Ford Lane Dyeworks, Bailey Street, Pendleton, Lancs. Registered June 9. Nominal capital £3,000 in £1 shares. To adopt an agreement with G. G. Brennand, to carry on the dyeing, bleaching and finishing business formerly carried on by the Phoenix Bleaching and Dyeing Co., Ltd., at Ford Lane Dyeworks, Pendleton, Lancs., and that of chemical manufacturers, manufacturers of cotton, silk, and woollen goods, etc. G. G. Brennand, of Brook House, Congleton, Ches., is to be included in the first directors.

Utiloid, Ltd. Registered June 13. Nominal capital £500 in £1 shares. Manufacturers and producers of and dealers in chemical substances used in manufacture, anti-corrosives, raw or partly prepared vegetable, animal and mineral substances and articles made or partly made therefrom, etc. A subscriber: J. Hind, 55 Crowstone Road, Westcliff-on-Sea; R. K. Hardy.

From Week to Week

ST. ANDREW'S UNIVERSITY has awarded its William J. Matheson Bursary of £50 in the Department of Chemistry to Miss Anita M. Walker, Southend-on-Sea.

THE STRIKE which broke out last month at the Tomaszow Artificial Silk Works, Warsaw, has now been settled, and work is gradually being resumed.

THE DEATH OCCURRED on June 12, at 54 Leslie Street, Pollokshields, Glasgow, of Mr. Archibald Aitchison, formerly of Chance Brothers and Co., Ltd., aged 84 years.

PROFESSOR F. G. DONNAN, professor of general chemistry in the University of London, was elected an honorary member of the Bunsen Society at its thirty-eighth annual meeting held at Carlsruhe, Germany, on May 26-28.

THE STURTEVANT ENGINEERING CO., LTD., has recently received an order for the installation of a Sturtevant electrostatic precipitator to deal with noxious fumes from an industrial process. The installation is of about the size employed by the average gasworks for de-tarring, *i.e.*, 5 kVA.

IN CELEBRATION of "Sheffield Week," the Sheffield Chamber of Commerce has issued a souvenir brochure describing the environments of Sheffield and local industries. The book is attractively illustrated and gives a wealth of information concerning the neighbourhood, its history and industrial development.

BILLINGHAM FIRE BRIGADE was called on June 14 to the works of the Imperial Chemical Industries (Fertiliser and Synthetic Products), Ltd., Billingham, where a fire had occurred in the main research laboratory. Two hours' work was necessary before the firemen overcame the outbreak, which had originated inside the building.

RECENT WILLS INCLUDE:—Dr. John Thomas, of Wilmslow, a pioneer of the British dyestuffs industry, joint managing director of the dyestuffs group of Imperial Chemical Industries, £13,264 (net personalty £12,486). Mr. Charles Robertson Morrice, of Glasgow, of the firm of James A. Morrice (James Anderson and Co., Ltd.), farina, starch and gum manufacturers, Glasgow, £2,883, personal estate in Great Britain.

TO ENCOURAGE THRIFT among employees of Imperial Chemical Industries, Ltd., a new company has been formed under the name of The I.C.I. Savings Bank, Ltd. The objects of the company are to carry on the business of a savings bank, to receive deposits from the staff, employees and workpeople of Imperial Chemical Industries, Ltd., and any of its subsidiary companies on such conditions as from time to time may be determined. The directors are John Rogers, Philip C. Dickens, R. L. Roberts, and J. M. King (director, treasurer, chief labour officer and departmental manager respectively of Imperial Chemical Industries, Ltd.). The registered office of the company will be at Imperial Chemical House, Millbank.

THE IMPORT DUTIES ADVISORY COMMITTEE has received an application for an increase in the import duty on wrought cased tubes of iron or steel; plates, sheets, strip, wire, rods, sections and tubes of brass and alloys of copper, other than nickel alloys; plates, sheets, strip, rods (other than wire rods), sections, wire and tubes (but not including tube shells) of copper; plates, sheets and wrought forms of nickel; ingots, billets and wrought forms of nickel alloys, other than those containing 60 per cent. or more of nickel; rolled sheets, prepared for use in printing and engraving, strip and wire of zinc. Representations should be addressed in writing to the Secretary, Import Duties Advisory Committee, Caxton House (West Block), Tothill Street, Westminster, London, S.W.1, not later than July 17.

ADVERTISING AND WORLD RECOVERY is the theme that will engage the attention of the fifteen hundred delegates who are attending the ninth annual convention of the Advertising Association, which will be held in London from July 18 to 21. The convention will be opened by the Prime Minister and the whole Empire will be represented, as well as many foreign countries. Problems of world recovery will be dealt with by authorities who have steered many businesses to success during the difficult period of the past few years. An analysis of the returns of the limited liability companies who publish trading figures, shows without exception that the businesses which employ advertising in connection with their sales policy, have suffered far less than those firms who do not employ advertising. At the convention new opportunities and new methods will be discussed. Many business leaders who have weathered the storm of depression will explain how they accomplished it. Apart from the spoken word, the Advertising Convention will run concurrently with the Advertising Exhibition, which opens at Olympia on the previous day, July 17. Particulars regarding the programme of the convention may be obtained from Mr. G. Russell Chapman, secretary of the Advertising Association, 110 Fleet Street, E.C.4.

A WORKING MODEL of a plant used for the hydrogenation of oil is displayed at a shop in Deansgate, Manchester, by the Anglo-American Oil Co.

DR. H. G. COLMAN has been appointed as a representative of the Institute of Chemistry on the Sampling of Tar Products Committee of the British Standards Institution.

THE REGISTERED AND ADMINISTRATION OFFICES of the Horseley Bridge and Engineering Co., Ltd., have been moved from 85 Lionel Street, Birmingham, to Horseley Works, Tipton, Staffs.

FURTHER LISTS OF BOOKINGS of the British Road Tar Association's films, "Tar" and "The Highway" for exhibition in provincial cinemas have been issued. "The Highway" is being shown at sixty cinemas during the next four weeks, and "Tar" at four cinemas.

ON THE SUGGESTION of Mr. Edgar Lewis, hon. secretary of the Bristol and South-Western Counties Section of the Institute of Chemistry, and on the recommendation of the finance and house committee, a conference of hon. secretaries of local sections will be held at the Institute of Chemistry to-day (Saturday) to discuss matters of general interest affecting the work and proceedings of the sections.

THE LARGE MODERN STEEL PLANT at the works of Steel, Peach and Tozer, Rotherham, is on full working time for the first time for many years. Three shifts a day, each of eight hours, are being worked. Order books are very well filled, and there is a constant accession of new business, due in part to the restriction upon imports by continental steel materials imposed by import duties. The works form part of the organisation of the United Steel companies.

A SPECIAL SERVICE for the study of agricultural and animal husbandry problems has been established in Venezuela by Presidential decree. Scientific studies and experiments will be conducted in regard to soil, fertilisers, nourishment, insects and diseases of plants, as well as other farm and cattle problems. This service will consist of a chemical-biological laboratory which will function under the direction of the Ministry of Health, Agriculture, and Animal Husbandry.

RESEARCH CHEMISTS and other users of fine chemicals will be interested in the new edition of the "Director of British Fine Chemicals," produced by members of the Association of British Chemical Manufacturers. The list contains the names of some 3,500 fine chemicals manufactured by over 40 firms, and a system of including an index to manufacturers on each left-hand page of the text is a very useful aid to quick reference. The directory is published by the Association at 166 Piccadilly, London, W.1.

A CONFIDENTIAL REPORT on markets for scientific and optical instruments, based on information received from the senior British Trade Commissioner in India and the British Trade Commissioner at Bombay, has been issued by the Department of Overseas Trade to firms whose names are entered on its special register. United Kingdom firms desirous of obtaining a copy of the report, together with particulars of the special register service of information, should apply to the Department of Overseas Trade, 35 Old Queen Street, London, S.W.1. Reference No. B.Y. 7582 should be quoted.

LORD DERBY will open the Advertising and Marketing Exhibition at Olympia, London, on July 17. As president of the Travel Association his support of the exhibition is particularly gratifying, for the exhibition is to be truly international in scope and exhibitors and delegates are coming from many lands. Indeed, Empire delegates to the Convention, which is being opened by the Prime Minister the following day, are already arriving in this country, and other parties have already left Australia. Benn Brothers, Ltd., publishers of THE CHEMICAL AGE and other technical and trade journals, are showing at the exhibition. Their stand is next door to the Pillar Hall Restaurant in the main hall on the ground floor. The number of the stand has been altered and is now New Stand No. 43.

THE BRISTOL AND SOUTH WESTERN COUNTIES SECTION of the Institute of Chemistry paid a visit of inspection to Darlington Hall Estates on June 10. There was a large attendance, which included Dr. E. Vanstone, chairman of the section, Mr. E. Russell, public analyst, Bristol, Mr. H. F. Burke, Mr. A. Marsden and Dr. Monkhouse. The members of the party were received by Dr. W. H. Slater, managing director, and Mr. Pearson, guide-demonstrator. Amongst the departments visited were the laboratories, textile, sawmills, and model farm. The party subsequently visited the restored Tudor mansion and beautiful grounds. During the serving of refreshments, Dr. Slater outlined the company's unique experiments in rural development and apologised for the absence of Mr. and Mrs. Elmhurst. After a brief visit to Buckfast Abbey, a dinner was held at the Courtenay Restaurant, Newton Abbot, which was presided over by Dr. E. Vanstone.

SULPHURIC

ALL STRENGTHS

Hydrochloric, Nitric, Dipping, Hydrofluoric, Lactic, Perchloric

F. W. BERK & CO., LTD.

Acid and Chemical Manufacturers since 1870.

106 FENCHURCH ST., LONDON, E.C.3

Telephone: Monument 3874. Wires: Berk, Phone, London.

Works: Stratford, E., and Morriston, Glam.

TAS/Ch.145

DRYING APPARATUS AND DRYING PLANT

FOR ALL PURPOSES

Complete Chemical Plants

PROCESS — ERECTION — OPERATION

Works: CARLISLE — **L. A. MITCHELL LTD.** Phone: CHEMICAL ENGINEERS BLA. 7106-7

37 Peter Street, Manchester

LACTIC ACID

SULPHONATED OILS

TANNERS' MATERIALS

BOWMANS (WARRINGTON), LTD.

CHEMICAL MANUFACTURERS,

Moss Bank Works : : : Near WIDNES.

CARBONATE of AMMONIA

PRECIPITATED CHALK

(extra light)

BROTHERS CHEMICAL CO. (1922) LTD.

TRAFFORD PARK, MANCHESTER.

THE SCIENTIFIC GLASS-BLOWING CO.

(MANCHESTER)

EXPERTS FOR ALL KINDS OF SPECIAL DESIGN APPARATUS IN **SODA, PYREX, JENA** AND OTHER LEADING RESISTANCE GLASSES, **QUARTZ** AND **VITREOSIL.**

PYROMETER & COMBUSTION TUBES IN PYTHAGORAS COMPOUND; gas tight at 1,400°C. maximum heating temperature 1,750°C. List with full particulars on application

REPAIRS UNDERTAKEN AT OWNERS' RISK.

SOLE ADDRESS:

12-14 WRIGHT STREET, OXFORD ROAD, MANCHESTER.

'Grams: "Soxlet" M/C. 'Phone: Ardwick 1425.

OLEUM (all strengths)

Sulphuric, Battery, Dipping, Muriatic, Nitric, and Mixed Acids.

SPENCER CHAPMAN & MESSEL Ltd.

With which is amalgamated WILLIAM PEARCE & SONS, Ltd.

WALSINGHAM HOUSE, SEETHING LANE, E.C.3.

Telephone: Royal 1166. Works: SILVERTOWN, E.16.

Telegrams: "Hydrochloric Fen, London."

BENNETT & JENNER LTD.

SPECIALITIES

LIME BISULPHITE 1060 & 1070
SODA BISULPHITE, SOLUTION
ACID SULPHUROUS,
CALCIUM CHLORIDE, PURE CRYST.
CALCIUM CHLORIDE FUSED
CALCIUM CHLORIDE, FUSED POWDER
DRY CALCIC SULPHITE, 42 SO_2
POWDERED SILICA

CLAYPOLE RD., STRATFORD, LONDON, E.

Telephone: Maryland 2058

GLYCERINE

We supply all grades for pharmaceutical and industrial purposes. May we have your inquiries?

GLYCERINE, LTD.

Unilever House, Blackfriars, London, E.C.4

'Phone: Central 7474. GET-2-254 Telegrams: Glymol, Lud, London

BRITISH ASSOCIATION OF CHEMISTS

Unemployment Insurance. **Over £8,250 paid**

Legal Aid. Income Tax Advice. Appointments Bureau

Write for particulars to:—

GENERAL SECRETARY, B.A.C., "EMPIRE HOUSE," 175, PICCADILLY, LONDON, W.1

'Phone: Regent 6611

ADVERTISERS please note that the latest hour at which we can accept advertisements for insertion in these columns each week is 10 o'clock on Thursday morning.

APPOINTMENTS WANTED

(Prepaid—Twenty-seven words 1s. 6d.; every additional nine words 6d.) Replies can be received "Box , Office of this Journal," in which case our address is included in cost of advertisement, and charged as nine words.

BOYS of good character, well-trained and eager to work, will be gladly recommended by the Warden of the John Benn Hostel, Bower Street, E.1.

Metallurgical Section

January 7, 1933

Events on the Eve of 1933

THE last month of 1932 gave us two outstanding events. In the first place the conference of copper producers, held in New York, failed to reach an agreement for prolonging the restriction scheme. Secondly, a further and important step in the rationalisation of the steel industry of Lancashire was announced.

The result of the recent copper conference is not surprising. Recent developments, considered generally, were not favourable to the success of negotiations of that character. The imposition of the American copper tariff in June, 1932, did much to give a severe strain to international co-operation. More recently the American mines have added to the difficulties by exporting large quantities of copper to Europe in competition with other producers, who have been unable to retaliate owing to the protection afforded to the American market. In such circumstances it could not be expected that the British and Belgian representatives would be prepared to accede to the demands of the American producers for the right to transfer to foreign mines part of the operating quotas which were allotted to mines on home territory. The request of the Roan Antelope Copper Mine for a revision of its quota was one particular point which could not be considered unreasonable. Here special circumstances existed, for the Roan concern did not begin producing until the summer of 1931, and therefore did not share in the responsibility for the piling-up of stocks, but all the same it participated in the earlier conferences which were held in November, 1931, and March, 1932. Whilst accepting the quota allotted to it, this concern had not actually been able to demonstrate its true capacity, and on the occasion of the new conference (called to consider the situation for 1933) it was not surprising to hear a request for its quota to be based on the treatment accorded to other producers. Many producers were granted high percentages, considerably in excess of the Roan request, one quota being as high as 70 per cent. of its capacity. Another large producer insisted that it be allowed to produce greatly in excess of its quota for the first few months of 1933, compensating for this excess later in the year, and added to this the right to withdraw from the understanding on two months' notice.

With the breakdown of the conference it must be assumed that all restrictions on output will have ceased as from January 1. Such a position, however, cannot be contemplated without some anxiety, but the American interest will be more seriously affected than the British producers. The Rhodesian companies are fortunately placed in the matter of operating costs and can show profits with copper selling at its present price of £29 5s. per ton. If a further and substantial increase of supplies be realised, it is quite possible that prices will fall to levels which will make operations unprofitable for even the cheapest producer. The Rhodesian companies, however, will continue to face the position much better than the American undertakings. What action the producers will take early in the year remains to be seen. So far as America is concerned the termination of the agreement is not likely to be followed by an increase in output. Most probably production will be kept down to the present scale of 20 per cent. of capacity, but efforts may be made to cut the rate still further. The Americans have nothing to fear from foreign competition, as their home market is effectually protected by the high duty on imported metal. Empire producers, indeed, are not concerned about developments in the United States. It is the policy which will be pursued by the American-owned mines operating in other parts of the world which is a matter of importance, for the Americans, while protecting their own market, have made strenuous efforts to dispose of surplus metal in other centres.

Turning to the steel industry we find that the Lancashire Steel Corporation, started in 1930 under the auspices of the Securities Management Trust (one of the companies formed by the Bank of England to assist in the re-organisation of industry) has acquired the Whitecross Company, of Warrington. The Lancashire Steel Corporation, it will be recalled, was formed to take over the control of the iron and steel interests of the Partington Iron and Steel Co., the Wigan Coal and Iron Co., Pearson and Knowles, Ltd., and Rylands Brothers, all of Lancashire, a scheme being drawn up for the re-arrangement and consolidation of these businesses as one manufacturing unit. The scheme included new construction work to the extent of £1,750,000, and work has now been started on a continuous wire rod mill of the most modern design. Here steel rods will be manufactured from start to finish on one site. The process will begin with iron ore and coal as raw materials, and will be continuous through the manufacture of coke and pig iron to steel ingots, blooms, billets and wire rods. Transport from one works to another will thereby be eliminated, with a resultant lowering of costs of production.

The Whitecross Company, with an issued capital of £235,950. manufactures all kinds of wire products and produces finshed goods of a similar kind to those of Rylands Brothers. Its acquisition by the Lancashire Steel Corporation therefore seems to be a

desirable step as it will turn a serious competitor into a useful ally, whilst both companies will draw their supplies of wire rod from the new mill. Up to the present time large quantities of billets and wire rods have been imported from the Continent for the manufacture of wire goods. In that respect the position resembles that of the tube industry, where the final product is also manufactured largely from steel drawn from the Continent. Here, however, we already know that the ambitious plans prepared by Stewarts and Lloyds will eventually make that company entirely independent of foreign materials for its tube manufactures. The scheme of the Lancashire Steel Corporation will carry us a step further, and there is little doubt that the adverse balance on the overseas trading account of the United Kingdom will be diminished as a result of these two developments. Powerful financial interests are behind the scheme which the Lancashire Steel Corporation has undertaken, the bulk of the finance being contributed by participants who are members of the Bankers' Industrial Development Co., the second of the companies formed under the auspices of the Bank of England to assist industrial re-organisation.

Foundry Practice for Aluminium Alloys

THE effect of melting and pouring temperatures upon the outstanding characteristics of aluminium alloys is discussed by Dr. Edmund R. Thews in an article which appears in the November issue of "Canadian Chemistry and Metallurgy." While the mechanical properties of practically all technical alloys are influenced to some extent by general temperature conditions, comparatively very small temperature variations from the optima destroy the usefulness of most aluminium alloys. This problem is all too frequently settled by the practical rule that aluminium alloys must be cast at the lowest temperatures at which the metal fills the moulds. In practical foundry work, however, it is almost impossible to exclude all factors influencing the normal cooling of fused metals on their way from the furnace to the moulds, so that, even if all other factors are duly considered, and if the most favourable minimum temperature has been accurately determined, undercooling of the melts is an ever-present danger. A comparatively slight degree of undercooling exerts a strongly deteriorating effect on the mechanical properties of aluminium alloy castings by causing all or part of the moulds to be filled with sluggish metal, and since a small increase of temperature, say, 25° to 30° F. beyond the pre-determined optimum will hardly exert an appreciable influence on the important mechanical properties of the castings, the rule cited should be modified so as to remain on the safe side of the temperature scale. Another characteristic feature of aluminium alloys closely connected with the determination of pouring temperatures is the comparatively small difference between melting points and pouring temperatures, a phenomenon due to the high latent heat of fusion of aluminium. Thus while aluminium and its alloys require considerable heating at the melting temperatures before the metal commences to fuse, these alloys may be maintained at the respective points of solidification correspondingly long without actually becoming solid.

Effect of Hot and Cold Pouring

IT has been pointed out that the pouring temperature of aluminium alloys is influenced to a large extent by the composition of the alloys as well as by a variety of external factors, but that the pouring range determined by these facts is rather narrow in any case. The problem now arises as to the reason for the ill-effects of excessively cold and hot pouring. The influence of cold pouring on the mechanical properties of aluminium alloys appears to be established. The metal is sluggish, and, even if it manages to fill the moulds, no time is left for proper crystallisation. Primary and, eventually, secondary types of crystals predominate in the solidified mixtures, while the eutectic, required to form a strong and solid bedding holding these crystals in uniform distribution is suppressed. Castings of this type represents a jumble of strong and tenacious crystals insufficiently held together—and kept apart at the same time—and interrupted by cavities due not only to gases and impurities but also to physical cooling phenomena. Hot pouring, on the other hand, causes an excessive development of eutectic, leaving the metal weak and deficient. Gas absorption also plays an important part in the development of the mechanical properties of aluminium alloy castings, but no account of de-gassing and refining will change this relation between pouring temperatures, mode of crystallisation and properties of the castings. Another physical factor of deciding influence is the melting temperatures of aluminium alloys. Although generally recognised, very little agreement appears to have been reached concerning this point. Some authorities advise not to raise the melting temperatures above the minimum temperatures required to obtain a homogeneous melt, that is to say, about 1,200° to 1,400° F. Others believe that superheating the aluminium alloys to as high as 1,550° to 1,650° F. is advisable in order to facilitate the separation of solid impurities.

A Standard for Enamelled Copper Wire

SINCE the issue in 1922 of the first edition of the British Standard Specification for enamelled high-conductivity copper wire, considerable improvement has been made in the manufacture of this material, with a corresponding improvement in the quality of the product. This development has been greatly assisted by the investigations carried out by the Electrical Research Association, and the results of these investigations have enabled a revision of the British Standard Specification to be made. It has, for instance, been found possible to make the requirements regarding freedom from pinholes much more stringent than in the old specification. In addition, the maximum permissible overall diameters of the enamelled wires have been slightly reduced, without any reduction in the severity of the high-voltage test. The methods which are now adopted of carrying out the mechanical tests simulate more closely practical conditions, and although the diameters of the mandrels on which the wires are wound are greater, the present test is more satisfactory than the old test. It has not been found practicable to dispense with the "rough and ready" thumbnail test which is found so useful by an experienced person, but an improved form of test for inflammability of enamel has been substituted for the original test.

Non-Ferrous Metal Mould Castings

By F. R. FRANCIS

Present-day practice in die casting was dealt with in an address which Mr. F. R. Francis, of the Canada Metal Co., Toronto, recently delivered to the Steel Treaters' Association. Extracts from this address are given below.

DIE casting has become known as the art of forcing molten metal under pressure into a permanent metallic mould or die. The alloys used may be tin base alloys, in which tin is alloyed with copper, antimony and lead; lead base alloy with antimony or antimony and tin; zinc base alloy, with copper and aluminium; aluminium base alloy with copper, nickel, silicon, iron, manganese, and magnesium; or copper base alloys with aluminium, tin, lead, zinc, nickel and other metals. The tin base alloys run from 60 per cent. to 90 per cent. tin, with varying amounts of copper, antimony and lead, and constitute the bearing or "babbitt" mixtures used in the production of main shaft and connecting rod bearings for the automotive and aircraft industry, where economical and fast production of high class bearings are essential. Tin base castings are used in the manufacture of parts for soda fountains, milking machines, syrup pumps, thermos bottles and similar apparatus where resistances against the action of acids, alkalis and moisture is necessary.

Lead Base Alloys

Lead base alloys run from 80 per cent. to 95 per cent. lead; antimony up to 17 per cent.; tin up to 5 per cent. They are usually employed where cheap non-corrosive metal is required, and where strength, hardness and other mechanical properties are unimportant, and find their greatest field in industries where the corrosive action of mineral acid is a factor. For example, chemical industries require valves that must not be subject to electrolytic action. This has resulted in the development of an all-lead valve which is made by the permanent mould process and in which the physical weakness of the lead has been overcome by the use of steel and bronze inserts cast integral with the lead. Where greater strength is required, the bronze or steel parts are covered with lead to a minimum of one-eighth of an inch in thickness, but where strength is not essential, solid lead is used. The method of casting these parts has been developed to the point where the metal therein is equal in density to that of extruded material and certainly far denser than castings produced by standard sand casting practice. Storage-battery makers are probably the largest producers of lead base die castings. Formerly very thick grids were used and produced by hand but now grids are half the weight and made by automatic die casting machines. One machine may produce 150,000 per day. The unit weight of lead base alloys is another factor in their use, particularly in die cast clutch parts and governor balance weights.

The tin and lead alloys do not offer the same difficulty, and in the early days of the pressure casting industry a foreman could mix alloys indiscriminately as long as they produced the best average results. About 1920, however, it became recognised that the best results could be secured from zinc 86 per cent., tin 9 per cent., copper 5 per cent., with slight traces of aluminium and bismuth. The physical properties thus secured were: a tensile strength of 16,000 lb. per sq. in.; elongation 2 per cent. in two inches; compression strength 27,500; Brinell hardness 60 to 65.

Difficulties were encountered in making castings of this type, failures including warping, brittleness and the destruction of original dimensions. These results were aggravated if castings were exposed to liquid or moist conditions. It was possible to have wall-thickness actually double. Difficulties were overcome by closer attention to metallurgical aspects of the work and standard alloys of this kind now range in content as follows: zinc, 93 per cent. to 95 per cent.; aluminium, 3 per cent. to 5 per cent.; copper, 2 per cent. to 3 per cent. In alloys of this composition range, the physical properties have been greatly improved. As a result, zinc base castings are used in large quantities, and as long ago as 1928, 30,000 tons of zinc went into die castings in the United States. The automobile industry is a large user of parts of this type. Washing-machine manufacturers and makers of electric motors, fans, vending machines, refrigerators, and cash registers rely on zinc base die castings for cost reduction and increased quality.

Pressure-cast zinc base castings are invading the pressed steel field and are competitive with steel products. Here one of the greatest difficulties from a metallurgical standpoint was to produce a metal that overcame the porosity experienced in producing castings having heavy sections. Zinc base alloys are also finding extensive use in the old process of slush castings. In this work, a mould is filled with metal and after a period of a few seconds is inverted and the still molten metal allowed to flow out, leaving a very thin-walled casting. The largest field for this work is in the manufacture of electrical fixtures. Comparing the zinc base metal castings with those of lead base, the finer details of design can be produced and a better finish applied with zinc. The latter is also stronger and less liable to damage, due to handling in either further manufacture or assembly. With these advantages the lower cost for equal volume is important, but the amount of impurities in alloy metals, although small, may be sufficient to cause much trouble in the work.

Although there are an unlimited number of aluminium base alloy compositions, those used in the metallic mould industry are limited to three grades: aluminium copper, aluminium silicon, and aluminium copper silicon and nickel alloys. An additional group gives great promise and is basically aluminium with copper, molybdenum and chromium. Castings of this alloy possess high resistance to acid and discolouration, and when polished resemble chromium plate. A typical alloy in this group would be: copper, 7 per cent. to 9 per cent.; silicon, 1 per cent. to 3 per cent.; iron, 2.5 per cent.; maximum impurities, 1.5 per cent.; balance, aluminium. This alloy would give tensile strength of 29,000 to 31,000 and elongation, 1 per cent. to 2 per cent.; yield point, 12 to 15,000; hardness, 75 per cent. to 80 per cent. In the silicon type the percentage of this element runs up between 11.5 and 12.5, with copper down to 0.6 as a maximum. In this case, the tensile strength is a little higher, up to 33,000, but the yield point is lower, down to 10 to 12,000, and elongation up to 3 per cent.

Porosity the Chief Difficulty

One of the greatest difficulties of pressure-cast work is that of porosity. It might be expected that, when metal is forced into a mould under pressure, a casting so made would be sound and dense. In the zinc base alloys, soundness is largely obtained by the method of gating and the pressure applied to the molten metal. With aluminium, the pressure and speed with which the metal is forced into the mould is so rapid that it does not allow the metal to give off the gases. It absorbs when in a molten condition before it is set. The result is that it is practically impossible to produce pressure-made aluminium castings that are solid in the interior. This condition becomes more aggravated when heavy sections are encountered.

What cannot be accomplished by the pressure method with aluminium can be done by the gravity casting method at such additional cost as the slower speed of the work makes necessary. The reason why so many thousands of pressure aluminium castings are being made every day is that, for a wide range of industrial parts, close calculations with respect to strength do not exist. All that is required is a light rigid part of adequate strength to do the work. If solidity and strength are essential requirements for this class, the gravity systems seems preferable. This was illustrated by the history of manufacturing motor housings as used on vacuum cleaners. This casting was originally sand-cast, then pressure-cast. In the latter case, there was a heavy cost of machining and breakage of tools when drills entered the porous section. This brought the cost above the sand-cast article. During the last three or four years, the article has been made by the gravity system with better results. When it is essential to hold dimensions within a high degree of accuracy, this is better done by the pressure system. In the case of some washing-machine castings, the natural finish of the gravity casting is acceptable; whereas the pressure casts have to be polished. Where production in reasonable quantity is

required, pressure and gravity castings normally give a lower finished unit cost.

Until a few years ago the commercial production of castings by the metallic mould process was limited to alloys of comparatively low melting points. The industry has learned to use higher melting point alloys. For example, tin base and lead base alloys with casting temperatures up to 650° F. were developed and these were followed by aluminium base alloys with casting temperatures up to 1,300° F. Difficulties multiply rapidly with the rise of the melting point of the alloy used. The life of the moulds decreases with ascending temperatures. Work has been done on special alloy steels and alloy iron and the heat treatment of moulds. In special cast work, machines had to be perfected to meet the increasing pressure for metals at higher temperature. By combined research and experience we now have both pressure and gravity systems producing commercial castings of copper base alloys. In pressure casting of this kind, the number of alloys used is few. A typical composition is: Copper, 57 to 59; zinc, 40 to 42; tin, 0.5 to 1.5; lead, 0.75 maximum. A pressure casting of this composition gives physical property such as tensile strength up to 75,000; yield, 35 to 40,000; elongation, 15 per cent. to 20 per cent. in two inches; Brinell hardness, 140. In the gravity-cast field, the alloys are mostly confined to those of copper and aluminium with small additions of nickel and iron. A typical alloy wiuld be: Copper, 90 per cent.; aluminium, 8.6 per cent.; iron, 1.4 per cent.; with corresponding increase in elongation and falling in hardness. A nickel alloy will average 75 to 80,000 tensile strength; 5 per cent. elongation in two inches, but the hardness goes up to as high as 200 Brinell.

The production of pressure-cast copper base alloys is still expensive and unless castings are required in large quantities the cost of dies would not be warranted. The mould and die cost is greater than that of similar equipment required for lower melting point alloys. This cost is due to the special steels required and the greater difficulty in working such material. Practice in copper base alloys is more advanced in Great Britain and Germany than in the United States.

British Industries Fair

New Metallurgical Products to be Exhibited

THE display of ferrous and non-ferrous metals at the British Industries Fair of 1933, at Birmingham, will mark a definite advance in metallurgical science. Developments will be noted especially in connection with rust-resisting and acid-resisting steels, and new nickel and aluminium alloys will be shown for the first time. Among the new products are high-speed steel alloys which, as well as their resistance to rust, heat and chemicals, have the combined merits of lightness, strength and toughness. There will also be on view light-weight alloys capable of withstanding exceptionally heavy strains. These products, drop-forged, are used in aeroplane and motor car production. A new aluminium alloy, actually lighter than aluminium, is interesting by reason of its resistance to corrosion in sea water. Stands constructed in the form of bungalows in which non-ferrous metals will be used to show the extent to which they can be applied in building. Here there will be examples of seamless copper and brass tubes of 6-in., 12-in. and 18-in. diameter; copper housing pipes for water and heating service; cupro-nickel condenser tubes and aluminium brass condenser tubes; locomotive boiler tubes in copper and brass; condenser and superheater tubes in solid copper and steel (copper coated); copper and brass rods for the motor and electrical trades; coils of extra-long copper tubing for panel heating; rolled brass, phosphor bronze sheet, ingots in copper and various brass alloys; and brass wire.

Among the finished products are high conductivity copper for electrical purposes, and for mechanical purposes the products comprise locomotive firebox plates, stayrods and accessories, seamless tubes, rolls for calico and wall-paper printing and numerous other applications, such as anodes. The range of alloys include aluminium bronze, copper cadmium and silicon bronze wire, bars, tubes, sheets and strip, cupro nickel, naval brass and phosphor bronze, in stampings, pressings, and other forms. An immense variety of extruded bars of Delta metal will also be shown.

Metallgesellschaft Profits

Share Capital to be Reduced

THE balance-sheet for the financial year ending September 31, 1932, submitted by the Metallgesellschaft, who are co-operating with the Amalgamated Metal Corporation in international metal trade, shows a small profit of 45,614 mks., which is being carried forward to the new account. The company intends cancelling 5,000,000 mks. nominal of its own ordinary shares, which it has hitherto held in reserve in connection with the option originally conferred upon subscribers of its 6½ per cent. sterling loan of £750,000 in 1928. The company's share capital will thereby be reduced further to 35,260,000 mks., after having been reduced last year by two-fifths. The resulting book profit of about 1,094,000 mks. is to be used for writing off participations. The profits resulting from the depreciation of sterling in respect of the company's sterling loan is given at 1,032,908 mks., which, as last year's book profit from the same source, will be allotted to a special reserve account, the latter thereby increasing to 3,761,205 mks.

Research on Protective Coatings

Additional Funds being Sought in United States

A RESEARCH programme for investigating the protective value of electroplated coatings on steel has been under way for several years at the United States Bureau of Standards. Results have already been obtained on such factors as the throwing power and porosity in nickel and chromium depositions. It is expected that inspection and examination at intervals during the next twelve months of the 7,000 specimens of copper, nickel, chromium, and zinc coatings now under test in various sections of the country will supply sufficient data upon which improved plating standards may be established. In order to expedite the investigation the American Electroplaters' Society has supported a research associate at the Bureau, and more recently the American Society for Testing Materials has also assisted in the work. At present, however, the funds for this purpose are almost exhausted, and the sponsoring society is asking the manufacturers and users of electroplated coatings to subscribe the funds to continue this work, in order that the past research investments will not be lost.

A Basic Steel Jubilee

France Honours Memory of Gilchrist Thomas

TO mark the fiftieth anniversary of the introduction of the basic steel process into France in 1882, a special meeting of the Société des Ingénieurs Civils de France was held in Paris on December 5, when the President of the Republic, M. A. Lebrun honoured the proceedings by presiding. Four addresses were given dealing with the history of the basic process, and another on the iron ore district of Lorraine. The Iron and Steel Institute was represented by the president, Sir Charles Wright, F. W. Harbord and G. C. Lloyd, who prior to the official proceeding were received in private audience at the Palais de L'Elysée by the President of the Republic.

The basic steel process which has made possible the utilisation of huge deposits of hitherto practically useless phosphoric ores, was the invention of Sidney Gilchrist Thomas (1850-85) who worked at the subject while a clerk in a London police court. His first paper, written in collaboration with his cousin P. C. Gilchrist, "On the Elimination of Phosphorus in the Bessemer Convertor" was to have been read at the Paris meeting of the Iron and Steel Institute in 1879, but for want of time had to be omitted. Thomas, however, was brought into contact with E. W. Richards and then with J. E. Stead, and a successful demonstration of the process was made on April 4, 1879, at the Cleveland Steel Works. Thomas, however, did not live long to enjoy his triumph; he died in Paris on February 1, 1885

The Continuous Refining of Lead Bullion

Operations at the Works of Broken Hill Associated Smelters

We give below extracts from a paper read before the Australian Institute of Mining and Metallurgy. The author, Mr. G. K. Williams, is Chief Metallurgical Assistant and Superintendent of the Research Department of the Broken Hill Associated Smelters.

In the new refinery of the Broken Hill Associated Smelters at Port Pirie, South Australia, the refining routine is similar to that carried out in the old one in that lead bullion is progressively refined, first for arsenic and antimony, then for copper and gold, then for silver, and finally, for zinc. Actual procedure, however, differs in that each refining operation is now conducted continuously, whereas in the old refinery intermittent batch treatment was practised.

The bullion received at the refinery had been previously drossed for copper in the copper-drossing plant, located in the blast-furnace department. The drossed smelter bullion was transported to the refinery in the liquid state, and was delivered first to the antimony softening furnace, in which the normal scorification was applied, the time allowed for the treatment being twelve hours. The softened bullion was then tapped into one of the two desilverising kettles, and two zincings were given for the removal of gold. The first gold zincing crusts were pressed and further treated for the recovery of their gold content, whereas the second gold zincing crusts were skimmed and returned to the first gold zincing of the next charge. A quantity of zinc, equivalent to 9 lb. per 2,240 lb. of bullion, was added to each second gold zincing. After the removal of the gold two additional zincings were given for the removal of the silver. The first silver zincing crusts were pressed and further treated for the recovery of their silver content, whereas the second silver zincing crusts were skimmed and returned to the first silver zincing of the next charge. Virgin zinc was added only to each second silver zincing.

The time required for de-golding and de-silverising was 24 hours; consequently, in order to allow the softening furnace kettles were required for each set. When de-silverisation was completed, the de-silverised lead was transferred to the zinc refining furnace in which the normal scorification process was to be operated on a 12-hour time-table, two de-silverising applied. The time allowed for this treatment was also 12 hours.

Bullion Storage Plant

The new refinery consists of six sections, namely, the bullion storage section, the softening section, the degolding section, the desilverising section, the zinc refining section, and the moulding section. The bullion storage, softening and de-golding sections are direct coupled, and the de-silverising zinc refining and moulding sections are also direct coupled.

The bullion storage section consists of two bullion storage kettles, each of which is covered with a brick hood to minimise heat loss, and one 5-ton kettle. The drossed smelter bullion is conveyed in 15-ton ladles from the copper drossing plant to the refinery, where it is pumped into one of the bullion storage kettles. When the pump is not in use it is immersed in a lead bath contained in the 5-ton kettle to prevent cooling. The storage kettle is skimmed once each shift and the dross is delivered to the softening furnace. The bullion is pumped continuously from the storage kettle into a launder which discharges into the softening furnace. The bullion storage kettle pump is provided with a valve in its delivery pipe, by means of which the rate at which the bullion is continuously pumped from the storage kettle can be readily controlled. The storage kettle is provided with a float gauge, which enables the rate at which the bullion is being pumped from the kettle to be quickly and conveniently derived.

The typical analysis of drossed smelter bullion is: Copper, 0.068 per cent.; arsenic, 0.182 per cent.; antimony, 0.41 per cent.; silver, 47.2 oz. per ton; gold, 0.10 oz. per ton.

Heating and Oxidation of the Bullion

The softening section of the plant consists of two softening furnaces of the reverberatory type, water-jacketed, 50 ft. long by 11 ft. wide (inside measurements), and each heated by means of two oil burners; two antimony dross furnaces; and two hard lead 5-ton kettles. The drossed smelter bullion flows into the softening furnace at one end, and softened bullion overflows from the other end through one of two overflow notches, the second notch being provided as a stand-by. During the passage of the bullion through the furnace it is subjected to the heat from two oil burners controlled to maintain the temperature of the softened bullion flowing from the furnace within a narrow range around 750° C.; and secondly the oxidising influences of the furnace gases. The result of the heating and oxidation of the bullion is that the arsenic and antimony contents of the bullion are lowered, and the arsenic and antimony, which have been oxidised, enter the liquid antimony dross which tends to accumulate on the surface of the bullion, but which is made to flow over the bullion counter-current to the flow of the bullion in the furnace. This counter-current flow of antimony dross and bullion is obtained by removing the antimony dross as continuously as possible through an overflow notch situated at the same end of the furnace as the drossed smelter bullion enters.

The antimony dross is delivered through a water-jacketed launder to the continuous antimony dross furnace. The dross enters one end of the furnace and gradually passes through the furnace to the other end, where it is discharged through a slag overflow notch. During its passage through the furnace the dross is subjected to heat, and also comes in contact with the fine coal which is added to the furnace in definite quantities every 15 minutes. Thus, as the dross passes through the furnace, it is enriched both in arsenic and antimony, with the result that a relatively high-grade antimony-slag is produced. The hard lead reduced from the dross, during the treatment in the continuous antimony dross furnace, overflows, continuously from the furnace into a 5-ton kettle, from which it is intermittently pumped and delivered to the softening furnace.

The typical analyses of the products of this section are: Softened Bullion—copper, 0.07 per cent.; arsenic, less than 0.0005 per cent.; antimony, 0.03 per cent.; silver, 47.70 oz. per ton; gold, 0.10 oz. per ton. Antimony Slag—arsenic, 8.6 per cent.; antimony, 20.0 per cent.; lead, 56.3 per cent.; silver, 0.3 oz. per ton.

De-silvering Plant

The de-silverising plant consists of three storage kettles; four pre-heating furnaces; and three silver kettles, each of which hold 360 tons. The bullion, pumped from the degolding section in 20-ton batches, is received in one of the storage kettles. It is pumped continuously from the kettle into a launder, which discharges into the pre-heating furnace; the rate of delivery is controlled by a valve in the delivery pipe of the pump and can be quickly derived from the float gauge provided in the storage kettle.

The de-golded bullion flows through the pre-heating furnace and thence to the de-silverising kettle. The function of the pre-heating furnace is to maintain the temperature of the bullion as it enters the silver kettle at 700° C. The top casting of the silver kettle is nearly completely filled with zinc-silver alloy, which, on account of its lower specific gravity as compared with lead, exists on top of the bullion in the kettle. The de-golded bullion on entering the kettle comes in contact with this zinc-silver alloy and also with the crusts liberated from the bullion in the lower cooling sections of the kettle. Consequently, an equilibrium tends to become established whereby conjugate solution exists; that is, the bullion tends to attain the compositions of the bottom solution which is in equilibrium with the top solution or zinc-silver alloy existing in the kettle.

As the bullion is displaced down the kettle its temperature is gradually decreased until approximately the eutectic temperature is attained at the point of entry of the bullion into the syphon pipe. The crusts, which are liberated from the bullion during its cooling to the eutectic temperature, rise into the top casting where portion is dissolved in the incoming bullion. The remaining portion melts and passes into

the zinc-silver alloy. Thus, at the treatment of the de-golded bullion proceeds, the silver content of the silver-zinc alloy gradually increases until it reaches the value of 7,000 oz. per ton. The alloy is then removed from the kettle, and zinc is added until the thickness of the low-grade silver alloy layer thereby formed is 2 ft. 10 in. The addition of zinc is then discontinued, with the result that the temperature of the alloy gradually increases from 530° C. to 600° C.; at the same time the silver content of the alloy gradually increases to 7,000 oz. per ton, and it is removed from the kettle. During the removal of alloy from, and the addition of zinc to, the kettle, the continuous treatment of bullion through the kettle is maintained. Under Port Pirie conditions, removal of alloy from the kettle occurs approximately once every 24 hours.

Typical analyses of the products of this section are:—De-silverised Lead—copper, 0.0004 per cent.; antimony, 0.0280 per cent.; zinc, 0.5600 per cent.; silver, 0.0300 oz. per ton. Silver Alloy—lead, 15.0 per cent.; copper, 0.5 per cent.; zinc, 64.0 per cent.; silver, 6,000 oz. per ton. Retort Bullion—lead, 39.00 per cent.; copper, 1.40 per cent.; arsenic, 0.01 per cent.; antimony, 0.01 per cent.; zinc, 6.60 per cent.; silver, 17.000 oz. per ton; gold, 0.26 oz. per ton.

Zinc Refining Process

This section will consist of two zinc refining furnaces. At present only one furnace has been constructed. This furnace is in operation, but is still in the development stages, especially as regards its size; consequently, it will be some time before the zinc refining section of the new refinery is completed. The de-silverised lead from the silver kettle gravitates through a launder to the zinc refining furnace. The lead flows into the furnace at one end and refined lead overflows from the other end through one of two overflow notches, the second notch being provided as a stand-by.

During the passage of the lead through the furnace it is subjected to the heat from two oil burners, controlled to maintain the temperature of the refined lead flowing from the furnace within a narrow range around 750° C., and the oxidising influences of the furnace gases. The result of the heating and oxidation of the lead is that the zinc and last traces of impurities, such as antimony, are removed, and appear in the form of a dross which tends to accumulate on the surface of the lead. Accumulation of the dross is prevented by periodic removal of it from the furnace by skimming.

Typical analyses of the products of this section are: Refined Lead—copper, 0.00030 per cent.; bismuth, 0.00100 per cent.; cadmium, 0.00010 per cent.; tin, nil; antimony, 0.00170 per cent.; iron, 0.00040 per cent.; zinc, 0.00023 per cent.; sulphur, 0.00030 per cent.; lead 99.99571 per cent.; silver, 0.00010 per cent. Refiner Dross—zinc, 11.0 per cent.; antimony, 0.5 per cent.

Some Recent Metallurgical Patents

Adsorbent Aluminium Oxide

An adsorbent aluminium oxide coating can be produced on articles made of aluminium or of alloys containing at least 50 per cent. of aluminium by immersion in or by spraying with an aqueous solution of sodium carbonate and potassium dichromate, with or without applied electrolysis. The coating is then coloured by treatment with a solution of a salt of permanganic acid, *e.g.*, sodium or potassium permanganate. (See Specification No. 381,402, of R. S. Dunham.)

Improvement of Aluminium Alloys

Aluminium and aluminium base alloys can be treated to improve their properties by heating the metal or alloy to a temperature not substantially higher than 100° C. above the melting temperature and adding a boron compound dissolved in a flux which contains stable ingredients non-reactive towards each other and which is capable of dissolving the products formed by the reaction between the boron compound and the metal or alloy. The molten metal and flux may be agitated. Most solid and many liquid boron compounds are suitable, for example, boric acid, borates, boron sulphide, carbide double salts of boron, etc. The flux preferably has a melting-point close to that of the metal and may comprise, for example, potassium chloride, sodium chloride, and cryolite with or without calcium fluoride. In an example the treatment of an aluminium copper alloy containing 8 per cent. of copper is described. (See Specification No. 381,668, of The National Smelting Co.)

Treating Metallic Surface

To protect magnesium or high grade magnesium alloys from corrosion by water, alcohols, or non-oxidising saline melts, particularly at elevated temperatures, the metal can be exposed to the action of an alkali metal sulphide, *e.g.*, sodium or potassium sulphide or liver of sulphur. The metal may be treated with an aqueous solution of the sulphide prior to contact with the corrosive agent or a small amount of sulphide may be added to the corrosive agent. For example, a small amount of sulphide, *e.g.*, 3 per cent., is added to a potassium thiocyanate melt used in the heat treatment of magnesium or its alloys. Water may be rendered non-corrosive in contact with the metal by adding 0.2 to 0.5 per cent. of sulphide to the water. Cooling liquids which come in contact with magnesium or its alloys, particularly in internal-combustion engines, and which consist of one or more alcohols, *e.g.*, glycol or glycerine, or aqueous solutions thereof are rendered non-corrosive by adding 0.1 to 0.5 per cent. of alkali sulphide. (See Specification No. 381,088, of the I. G. Farbenindustrie.)

Recovery of Metals

In a process for the recovery of metals such as tin, lead, antimony, bismuth, etc., or alloys of the metals with or without precious metals contained in the residues obtained during the reduction of materials containing these metals in the form of oxides by the process described in Specification No. 367,611, any cooling of the residues withdrawn from the furnace to a temperature below the solidification temperature of the reduced metals can be prevented by conserving the heat in the residues or by supplying heat to them, in order to obtain the metals in a cohering molten form and the residues are shaken to facilitate the union of the metal particles. Tappings from several furnaces may be collected in one container adapted to be shaken and preferably having heating means, a perforated false bottom, and tapholes below the bottom. The yield of metal from the residues is increased by making up the charge into a paste with solutions of the requisite fluxes such as sodium carbonate, waterglass, etc., or by sintering the oxides to be reduced with or without additions of the fluxes before adding the reducing agent. (See Specification 380,884, of A. L. Mond.)

Non-Adherent Surfaces

The interior surfaces of metal barrels, drums, etc., for asphalt, bitumen, tar, or pitch, which tend to adhere to the surfaces of metals can be rendered non-adherent by applying to the surface which has or is given a coating of metal oxide liquid or semi-liquid reagents which loosen the film of oxide. The reagent may react with the metal to form hydrogen or may react with the metal to a greater extent than with any coating carried by or formed on the metal, or may produce by chemical reaction of its own components substances having these properties. The reagent may also form or deposit hygroscopic substances on the interior surface of the container. The ordinary coating of magnetic oxide of iron may be employed in the case of iron and steel containers, or these containers may be allowed to rust or be heated to form the coating of magnetic oxide. The reagent may be a solution of an organic acid whose action is quickly inhibited. Acid salts or substances reacting to form acids or acid salts may be used. Oxalic acid or sodium dihydrogen phosphate accompanied by a hygroscopic substance such as glycerine and water may be used, or orthophosphoric acid and a salt such as commercial chloride or nitrate of an alkali metal or ammonium, or alkaline earth metal, or iron, aluminium, manganese, zinc, or magnesium with water, such salt being hygroscopic and capable of reacting with the acid to liberate free hydrochloric or nitric acid. (See Specification No. 381,632, of J. M. Sanders.)

Metallurgical Section

February 4, 1933.

The Outlook in the Iron and Steel Industry

FURTHER proposals for the internal reorganisation of the steel industry are apparently under discussion. They were briefly referred to in an official statement which followed the meeting of the Heavy Steel Makers' Association on January 18, when it was "unanimously decided that existing associations dealing with heavy steel plates, sections, and joists for home and export trade should be continued with a view to their being replaced by more comprehensive arrangements." It is very probable that the sales aspect of the problem is to receive close consideration, for the National Committee dealing with the reorganisation of the iron and steel industry has an eye upon sales as well as producing activities, and it may be added that the heavy steel makers have a number of committees or associations which concern themselves with price fixing and similar trading matters. These associations embrace the interests of almost the whole of the manufacturers of finished steel, but their agreements are gentlemen's agreements and have no legal sanction. In times of depressed trade there is, however, some temptation to ignore price agreements in order to secure a greater share of orders to provide work for idle plant, and a tightening-up of the existing system of organisation, with the object of making these agreements legally binding, may be anticipated.

Almost simultaneously comes the news that definite attempts are now being made to bring to an end the excessive competition which has existed for the last few years between Cleveland pig-iron manufacturers and the ironmasters in the Midlands. Discussions upon this matter have been proceeding for some time and proposals have been put forward for dividing the country into zones, so that uneconomic price cutting may be avoided and the resulting heavy losses thereby eliminated. Competition has been especially severe in the Scottish market, where manufacturers from the North-East Coast, the Midlands, the Continent and India, have been endeavouring to secure business in competition with each other. But now that Continental pig-iron has been virtually excluded by reason of the British tariff, and an agreement has been made under which basic pig-iron will be imported from India on the basis of a fixed percentage of consumption at an agreed price, the North-East Coast and Midland makers should find little difficulty in overcoming their trading troubles. Under the proposed scheme for "zoning" the whole of Great Britain, the North-East Coast makers will have to respect the Midland makers zoned area prices, and similarly, the Midland makers will respect the North-East Coast area prices, and so far as the Scottish market is concerned they will agree to zoned areas North of the Tweed for their respective markets. The ultimate effect of this arrangement should stabilise prices and eliminate wasteful competition, whilst generally it will place the sale of pig-iron in the home market on a more rational basis.

The efforts which are being made to reconstitute the Continental steel cartel are only of indirect interest to the British iron and steel industry. The cartel of 1926 was formed to run for five years, ended in June 1931, and during its life sufficient difficulties were encountered to make an immediate renewal impossible. Originally only production was subject to control, for it was assumed that when production was regulated, markets would be found quite easily in home and export markets, whilst prices would settle themselves at a reasonably profitable level. But before the five years were completed, nationalism began to creep in. Some producers found that their home market was expanding, and in order to meet this demand they had the alternative choice of starving their own export market or of allowing other cartel members to take a considerable share of this new home trade. In consequence, production quotas were exceeded and objections were raised against paying the agreed fines for excess output, on the ground that the excess output resulted from the needs of the home market. In due course concessions were made and negotiations were started to convert the cartel more or less into an agency for merely fixing export and import quotas. Price difficulties followed, for it was soon found that consumption was so hard to assess that without some kind of price control the desired stability of prices could never be achieved. In 1930 a tentative selling agency was set up, but under the growing pressure of the slump it failed to secure its object, and then the cartel organisation became undermined by price cutting. Minor difficulties also arose, such as the claim of the Germans and Czechoslovaks to treat production for export to Russia as being outside the agreement. Any fresh attempt to reconstitute the cartel will, therefore, have its full share of minor problems as well as the fundamental ones.

In Germany the Government is expected to intervene in the steel industry in a way which may possibly have important international consequences, for since the acqusition by the Reich, of a majority interest in the Steel Trust, intervention would appear to be inevitable. At present the German steel industry, considered as a whole, is occupied to much less than 50 per cent. of its capacity. In 1932, the total industrial production value of the industries was 57 per cent. of the 1928 value, seven-tenths of the fall-off being due to reduced volume of output and three-tenths due to price fall, but the decline in iron and steel, considered alone, was to 38 per cent. of the 1928 value. Pig-iron output was

only 3,930,000 tons against 13,400,000 tons in 1929, which was the best recent year; steel production was 5,710,000 against 16,246,000 tons. These figures are relatively much worse than those of Great Britain, France and Belgium, but they are better than those of the United States. The smallest sufferers among the larger companies were Krupps and Mannesmann Tubes. The financial status of the Steel Trust is not made quite clear by its accounts, for it is a fusion, dating from 1926 of half-a-dozen companies and a considerable part of its sales are to its own semi-independent manufacturing branches. Sales to outsiders in the last business year were only £26,000,000 as against £72,250,000 in 1928-29.

All the great German steel companies are dividendless, and some of them have not even earned fixed charges and depreciation. Industrial construction, on which so much steel goes in good trade years, cannot revive until present excessive factory capacity is fully utilised, which will not be for years; domestic construction, on the other hand, is stagnant. What improvement there has been is mainly due to Russian and railway corporation orders, and to a small extent to the revival in demand for metal consumption goods. In the export market, however, Germany has become increasingly dependent on Russia. The official Soviet return is that Russia's pig-iron production last year (6,200,000 tons) exceeded that of Germany and of all other European countries, and that the steel output was 5,400,000 tons. It seems certain that Russia will either become self-sufficing or that her expansion plans will collapse, and in either case the German deliveries will cease. In consequence, the combined home and foreign demand for German steel is not likely soon to return to the level of four or five years ago.

Plain Words to the Steel Trade

How the British iron and steel industry is attempting to consolidate its position with the help of a duty on competitive imports was described by Mr. Charles Mitchell, chairman of the National Steel Committee, and chairman of Dorman, Long and Co., Ltd., on the occasion of the annual dinner of the London Iron and Steel Exchange on January 24. As the home trade of the industry only represented about 30 per cent. of the total trade, and as they had to look to the export trade and to the other nations of the world for the remaining 70 per cent., the merchants must be with them if they were to achieve the success they desired. The National Steel Committee were trying to find ways and means whereby the iron and steel trade could be so consolidated and so organised that the British iron and steel industry could continue to hold their own in export markets and to dominate the position throughout the world. In spite of the many difficulties in front of them they were inspired and given courage by the fact that Sir George May and his colleagues on the Import Duties Advisory Committee had whole-heartedly given the industry their support, and had said that they were behind them in everything they did so long as it was right and so long as they were determined to find means of giving the consumer the right material at the right price. With a little patience and a little time they would achieve their purpose. Duties had been given them to enable them to obtain the necessary production in the home market, so that they could bring down their cost of production in the world's markets in order that the United Kingdom, which was the birthplace of the industry, should again become the leader of the iron and steel trade. Personally he was a convinced Free Trader, but when 80 per cent. or more of the world under present conditions was attempting to conduct trade with the aid of tariffs, what could this country do but do likewise? Although the industry had a duty on imports that tariff was imposed for a set purpose—to provide them with the necessary protection in the home market whereby they could consolidate their position and bring down the cost of production and be facilitated in the competition in the world markets.

A Demand for Cheap Steel

Replying to the toast of "The Exchange," proposed by Lord Leverhulme, Mr. Frank Baxter, the chairman of the Management Committee, said that if the reorganisation of the iron and steel trade was to be successful the trade would have to satisfy the country that it could, given time, provide the steel requirements of British industries at a low price which would enable them to sell their finished products abroad. That was particularly necessary so far as semi-finished steel was concerned. It was of the utmost importance that they should supply steel at world competitive prices to the export markets and particularly those of South America, Scandinavia, and the Far and Near East. The demand from those countries was for cheap steel.

Sir George May, chairman of the Import Duties Advisory Committee, who also responded, said that the industry had got to put its house in order and to remember that the other steel producing countries of the world had been doing the same thing. Personally, he had never taken on a job he did not intend to "pull off." They would have to put up a scheme to the Government which held out a promise of successful reorganisation for the industry to meet the competition there was going to be in the future. He thought they would be successful. If they did not do it themselves, then someone else would have to do it for them.

United States Copper Industry

Advanced Statistical Summary for 1932

The smelter output of copper from ores of domestic origin in the United States in 1932 was about one-half that of 1931 and refinery production from domestic and foreign sources was 54 per cent. lower than in 1931. The severe cut in production is evidence of the efforts made by producers to bring production into balance with consumption.

According to an advance summary prepared by the Bureau of Mines the smaller production of copper from domestic ores in 1932, determined on the basis of actual production for 11 months and estimated production for December, was 528,000,000 lb., compared with 1,043,000,000 lb. in 1931. The 1932 production was thus about one-half that of 1931; it was the smallest production recorded since 1921, exceeding the output of the latter year by only 4 per cent. The estimated smelter production from domestic ores for December as reported by the smelters, was nearly 45,000,000 lb. which is slightly higher than the average reported for the 11 months preceding. Production of new refined copper from domestic sources, determined in the same manner as smelter production, was about 443,000,000 lb. compared with 1,075,000 lb. in 1931. The output of new refined copper from domestic and foreign sources in 1932 amounted to about 688,000,000 lb., compared with 1,502,000,000 lb. in 1931—a decrease of 814,000,000 lb. or 54 per cent. The production of secondary copper by primary refineries dropped from 156,000,000 lb. in 1931 to about 120,000,000 lb. in 1932.

Corrosion Research on Light Metals

The Future for Aluminium and Beryllium

At a meeting of the Chemical Engineering Group, held on January 13, Mr. Freeman Horn, of the British Aluminium Co., dealt with the subject of corrosion research on light metals, Mr. J. Arthur Reavell, Chairman of the Group, presiding. Extracts from Mr. Horn's paper are given below.

CERTAIN of the light metals and alloys, particularly those with a magnesium base, are subject to varying degrees of corrosion under certain conditions, such as salt spray, and increased attention is now being paid to research into the underlying causes of corrosion and the best or most economical methods of its prevention under varying operating conditions. There are five metallic elements which can be classed as light metals, namely, aluminium, magnesium, silicon, lithium, and beryllium, having specific gravities of 2.7, 1.8, 2.0, 1.8 and 0.53 respectively. Of these, the first two are the only ones which have so far been made the bases of industrial alloys. Silicon is not obtainable alone in the metallic state, but is added to aluminium up to 25 per cent. to produce a series of extremely useful alloys. Beryllium has so far not been obtained in a sufficient state of purity to determine accurately its true physical and mechanical properties, while no useful alloys of beryllium with aluminium have so far been discovered, though the remarkable properties which quite small percentages impart to copper give some hope for the future, and serve as an incentive to research.

Aluminium is by far the most important of the light metals, largely on account of its film-forming properties and consequent high resistance to corrosion. The metals with which it is chiefly alloyed are copper, silicon, zinc, magnesium, manganese, and nickel in the approximate order of their importance. Magnesium is alloyed mainly with aluminium or manganese, with small additions of other metals to obtain special properties. The resistance to corrosion of these various metals and alloys varies within wide limits, the pure metal being, in general, more resistant than alloys.

Corrosion Theories

Out of the mass of theories and counter-theories, the engineer is able to grasp what appear to be two fundamental truths, namely that corrosion of metals is essentially an electro-chemical phenomenon and that whatever resistance to corrosion is exhibited by any metal, even pure iron, is due to the presence of a microscopically, or even sub-microscopically thin and usually transparent film of oxide which forms, in some cases instantaneously, on the surface of the metal when exposed to air or other gas containing measurable quantities of oxygen. According to the first theory, corrosion is always caused by differences of electrical potential, or what chemists call differences of solubility pressure inside the corrosive medium either between the metal or alloy affected and some outside metallic body or between different constituents of the same alloy or even between different parts of the same metal. If this theory be correct, it follows that a chemically pure metal of uniform physical condition totally immersed in a chemically pure uniform simple solution will not corrode, and there appears to be increasing evidence to show that this is indeed the case. When, however, it is remembered that differences of potential can exist between different parts of a piece of pure metal due to differences of internal stress set up in cooling from the molten state, from mechanical working, from heat treatment and even from the means used to support the sample in the test tube, not to mention the difficulty of obtaining atomically pure materials, it will be realised how difficult it is to prove the truth of this theory.

Since according to the second theory, resistance to corrosion is merely some form of oxidation, and is due to the presence of a film of insoluble oxide on the surface, then immunity to corrosion will depend upon the thickness and impermeability of the oxide film formed under the given conditions, and its adherence to the surface and its insolubility in the corrosive liquid. In practice, the mechanical strength and resistance to abrasion of the film also play important parts, and this is particularly so with aluminium which is a relatively soft metal but whose normally formed oxide is extremely hard. The resistance of aluminium to corrosion by ordinary and salt bearing atmospheres is in contrast to its chemical reactivity, which is high, as evidenced by the instantaneous formation of an oxide film. It is only when aluminium is subject to alkaline conditions which dissolve the oxide and attack the underlying metal that serious corrosion takes place or when local elements are set up which prevent the formation of less stable, less adherent, or less insoluble forms of oxide or hydroxide.

Corrosion may be divided roughly into three main classes, namely, general corrosion in which the whole surface of the metal is attacked more or less uniformly; pitting, in which the attack is concentrated at particular spots; and so-called inter-crystalline corrosion, where the attack proceeds, frequently almost unobserved from the surface, downwards into the heart of the metal between the individual crystals. Aluminium and the simpler alloys of aluminium with metals which form homogeneous stable intermetallic solutions are remarkably free from any of these forms of corrosion under most atmospheric conditions, due to the tenacious and insoluble film of oxide and to the fact that no intermetallic differences of potential exist. Alloys of aluminium, however, which depend upon the presence of one or more intermetallic compounds insoluble, or partly insoluble, in the base metal, or still more to the precipitation in the solid state of such intermetallic compounds, usually in a fine state of sub-division, are more likely to be subject to corrosive influences by reason of differences of potential set up between the base metal and such intermetallic compounds.

Standard Procedure for Corrosion Tests

Apart from chemical plant, the only use of aluminium and aluminium alloys in which corrosion plays an important part is in the aircraft industry, where conditions dictate the use of special high-duty, heat-treated alloys, with the highest ratio of strength to weight possible, irrespective of corrosion resistance, but where, paradoxically, a very high resistance to corrosion is essential owing to the low factors of safety employed and to the comparatively thin sections involved where any loss of thickness becomes relatively series. A a result most of the corrosion research on light metals has been carried out on aircraft materials simulating the corrosive influences met with under aircraft operating conditions.

The chief European aluminium producers some years ago formed an International Propaganda Bureau to study all matters bearing on the development of new uses for aluminium and its alloys, and one of the useful works performed by the bureau has been the correlating of the different corrosion testing methods employed in the laboratories of the various producing companies and research institutions, and the drawing up of a standard corrosion test procedure to be followed by all the aluminium producers, which was recently issued in the form of a memorandum. This memorandum deals first with general considerations regarding methods of expressing composition of alloy, mechanical and thermal treatment to which it has been subjected and the nature and condition of the surface. It next recommends certain standard sizes of test pieces for cast and wrought material respectively and suggests the most suitable sizes of beakers, methods of cleaning and other practical details in carrying out corrosion tests. It advocates that all tests should be carried out at room temperature and that the test piece should be suspended in the liquid by means of two holes, top and bottom, to allow it to be inverted once a week.

Effects of Corrosion

The effects of corrosion, from the engineer's point of view, may be roughly divided into three main groups, according to the nature of the corrosion. In the first place uniform corrosion over the whole surface of the metal which results in a loss of tensile strength more or less in proportion to the loss of thickness or section and very little loss of elongation or its counterpart increased brittleness. This is the least serious of all forms of corrosion, first, because, for any total amount of corrosion the loss of strength is a minimum by reason of

its fairly equal distribution over the whole surface, secondly, because it is visible and its amount and seriousness easily computed and either allowed for or the part replaced when necessary, and, lastly, because a uniform corrosion acts to some extent as a protection to the underlying metal and no local elements between the metal and accumulations of corrosion products are likely to be set up.

Pitting or local corrosion is due mainly to differences of potential between the base metal and segregations of richer or poorer phases, or between different groups of phases, or external stresses. It results in a loss of tensile strength and elongation frequently out of all proportion to the loss of material through corrosion, and the more localised the corrosion, that is, the deeper the pits, the greater obviously will be the disproportion between loss of strength and loss of metal. Added to this, there is often a marked acceleration in the rate of corrosion as the depth of pit increases due to local elements set up by the retained and concentrated products of corrosion and to the pit retaining moisture and perhaps never quite drying out between wetting periods.

Intercrystalline corrosion is a form of corrosion the true extent and significance of which has only recently begun to be realised, but it is the most dangerous of all and the most difficult to combat, as there is frequently little evidence of it on the surface. It causes a loss of both tensile strength and elongation out of all proportion to either the visible or invisible loss of material and, in addition, may cause a serious loss of fatigue strength, *i.e.*, it reduces the maximum alternating stress which the part will indefinitely withstand, or reduce the number of such reversals of stress of any given magnitude which the part will withstand before fracture occurs.

Composition of the Metal

The most important factor affecting corrosion is the composition of the metal or alloy and its degree of purity, and a vast amount of research work has been carried out to determine the influence of both metallic and non-metallic impurities and of every conceivable alloying element on the corrosion resistance of both aluminium and magnesium alloys. What was probably the first systematic research into the relative corrosion of aluminium alloys was undertaken by the late Professor Wilson, of King's College, who at regular intervals over a number of years determined the electrical conductivities, the corrosion products and tensile properties of a number of light alloy wires suspended on the roof of King's College and subjected to the all-in-the-year-round action of London atmosphere. Since that time systematic research into the influence of composition on the resistance to corrosion of light alloys has been pursued in all countries, the outstanding feature of most of which appears to be that of the straight binary alloys; those containing some 12 per cent. of silicon (eutectic composition) and those with up to 2 per cent. of manganese are, under ordinary conditions, the most resistant to corrosion, the former being suitable for castings and the latter for sheet. More recently, the influence of small additions of other metals, including rare metals, on the resistance to corrosion of these high duty alloys has been systematically studied, largely behind closed doors in the laboratories of the various firms specialising in these products.

While much research has been carried on to discover the basic causes of corrosion and to develop alloys which by reason of their composition, method of production and working, or their final heat treatment offer the maximum resistance to corrosion, parallel researches have been going on in which methods of treating the surface of such alloys to prevent access of the corroding medium to the underlying metal are being investigated.

Prevention of Corrosion

The oldest and simplest method of protecting any structural material against the destructive action of air, rain, or sea water is by painting it, but the best of paints have a comparatively short life, particularly when subjected to the combined effect of alternating sun, moisture, and salt over wide ranges of temperature, which tends to loosen the adhesion between the paint and the metal. Paint is also easily damaged. There is still scope for research in this direction, which is, in fact, being actively pursued in all countries; in this country by the Research Association of the British Paint, Colour and Varnish Manufacturers at its laboratory at Teddington, and by the Corrosion Committees of the Iron and Steel Institute and the Institution of Civil Engineers. The high coefficient of expansion of aluminium alloys must be taken into account in considering the forms of protective coatings and it has been found that certain types of quick-drying enamels used on steel surfaces are insufficiently elastic for light alloys.

As no form of paint can equal in adhesive or mechanical properties the surface of the metal itself, research has been concentrated for some years past on discovering ways and means of making the surface non-corrosive. The main fields of research may be divided up into three groups :—

Metallising	... ...	Spraying or Rolling.
Plating	... ...	Zinc or Chromium.
Oxidising	... ...	Chemical or Electrical.

The purer the aluminium the higher the resistance to corrosion, and attempts have been made in Germany to protect alloys by spraying them with pure aluminium, but without much success since such sprayed surfaces are by their nature uneven and rather porous, even after subjection to a rolling process.

A Fruitful Line of Research

A more fruitful line of research was followed in America resulting in the production of a thin layer of high purity aluminium rolled into, rather than on to, the surface of duralumin during manufacture, and heat-treated with the latter. This, of course, represents some loss of strength, in the neighbourhood of 10 per cent. if both surfaces be treated, as the final heat-treatment anneals the pure aluminium cover, and such material is not immune from attack by alkali, but the pure aluminium has been found to protect the underlying metal at cut edges and deep scratches by electrolytic action. A certain amount of research work on chromium and zinc plating of aluminium alloys has also been carried out in this country. Both of these metals can be successfully plated on aluminium, and such plating is being done on a commercial scale for other purposes. Zinc has been found to give limited preferential protection, pure zinc being, under most conditions, slightly electropositive to duralumin.

Last, but certainly not least, come surface treatments proper, whereby the natural oxide film on aluminium is artificially increased in thickness and density to form a practically impervious and mechanically strong skin. The earliest application of this principle, to my knowledge, was worked more than 20 years ago in Germany by a firm called the Aluminium Spulen A.-G., who produced electric insulating layers of oxide on the surface of aluminium wires by passing them through an electrolytic bath, the wire acting as the anode. In the Bengough, or so-called anodic process, a 3 per cent. aqueous solution of chromic acid is used; the article to be coated is the anode and the steel tank the cathode, the liquid being maintained at a temperature of 40° C. and the voltage gradually raised from 0 to 50 volts over a period of one hour, during which a dense resistant coating of oxide forms on the surface of the metal.

Another process which gives somewhat less protection against corrosion than the Bengough but more than sufficient for ordinary atmospheric conditions and lends itself particularly to decorative effects by absorption of dyes in the anodic surface uses sulphuric acid as the electrolyte, while a still more recent process developed in Germany uses oxalic acid.

Points from the Discussion

Mr. L. WHITBY, who opened the discussion on behalf of Dr. Bengough, commented on what he termed the old fashioned statement in the paper that a pure metal of uniform physical condition, immersed in a chemically pure uniform simple solution, will not corrode. Contrary to what the author had said, there was increasing evidence that this was not so. The same comment applied to magnesium and magnesium alloys. It had also been said that a pure iron will not corrode, but Armco iron had been an absolute failure in that respect. As a matter of fact, the corrodibility of iron was considerably lessened by adding certain impurities. It was now fairly well established that corrosion starts up either at weak points in the air formed oxide film, which exists on the surface of all metals that have been exposed to the air, or else at lines of increased adsorption density in the metallic surface which might be caused by crystal corners and edges. Although it seemed to be generally considered that sodium chloride solution and sea water were identical for

corrosion purposes this was not so, due not only to the host of other salts contained in the sea water, but also to the traces of organic matter present.

Mr. S. ROBSON commented on the extraordinary importance of light metals in aircraft construction and added that all of those which had been mentioned in the paper were of comparatively recent industrial isolation. He looked to beryllium as likely to become of very great significance in the near future. His own view was that the purity of the metal had a very great influence on the corrosion resisting properties. In regard to metals of the aluminium class we had not sufficient information to know what the real significance of some of the commoner impurities was on the properties of the material when alloyed into such materials as duralumin and the other common forms of alloy. Whereas in the case of aluminium there was an oxide film, in the case of zinc and copper the protective coating was a basic carbonate or basic sulphate.

A Need for Authoritative Reports

Mr. C. J. GOODWIN commented on the fact that in this country we do not seem to have the equivalent of the German D.V.L., or Aircratt Research Bureau, which published some extremely interesting reports with regard to corrosion. It was a pity that the manufacturers of light alloys did not get together and issue authoritative reports of a similar nature. Beryllium was a very complicated material and he did not hope to see it at a low price in the near future. There was only about 2 per cent. of the metal in the raw material and the processes involved were expensive. At the same time, increasing work had made the metal purer and more ductile and it was becoming more useful than was at first thought likely. Nevertheless, he doubted if we should ever see the price of beryllium come down to a few shillings per lb. As to copper, he had obtained some results which were diametrically opposed to what anybody else had obtained. In some experiments on copper pipes using ordinary well water he had found that the rate of flow was almost as important as the temperature. Contrary to all accepted notions, hot water had a very marked corrosive effect on copper pipes provided the water was in motion.

Dr. A. J. V. UNDERWOOD referred to the necessity for correlating accelerated corrosion tests with field tests and mentioned a case which indicated that on occasion at any rate accelerated tests can be quite misleading. This was a case of some cooling coils for a certain process in which the cooling water was to be sea water. A number of alloys were tested by boiling them in sea water, as a decision had to be come to rather hurriedly. One alloy seemed to be satisfactory and was adopted, but after a few months corrosion took place and there was considerable leakage. The material was then tested in the laboratory with cold sea water and what happened was that this particular sea water contained a certain amount of calcium or carbonate in solution which, on boiling, formed a calcium carbonate scale which was sufficiently thick and uniform to resist further corrosion with the hot water with which the original test was made. When cold sea water, or comparatively warm sea water, was used this film did not form and pitting took place.

Film Formation of Primary Importance.

Mr. FREEMAN HORN, in his reply to the discussion, said he tried to make it clear in presenting the paper that he was not advocating any particular theory of corrosion because he did not pretend to be capable of doing so. All he had done was to pick out from the many conflicting theories those which appeared to him as an engineer to be most simply explained Film formation he regarded as of primary importance as there was a striking example of that in the aluminium-brass which had been developed by the British Non-Ferrous Metals Research Association for condenser tubes. Ordinary brass corroded rapidly under what was known as the impingement attack of sea water, but it had been found that the addition of 2 per cent. aluminium practically stopped that corrosion Beryllium was a very disappointing metal at the present time, but he believed he was right in saying that the latest researches had shown conclusively that the chemically pure metal is extraordinarily ductile and he looked forward to the time when commercially it would be possible to obtain chemically pure beryllium. He disagreed with Mr. Goodwin's comments about the D.V.L., and the position in this country.

Protective Coatings for Aluminium

A New Process Developed in Germany

THE Lanta Werke, the largest producer of aluminium in Germany, has developed a method of producing a thin oxide coating on aluminium which protects it from corrosion. The chemical composition of the protective coating is said to be identical with corundum and to possess the same hardness. Furthermore, the new product is claimed to be non-porous and colourless and does not change the appearance of the metal. The new coating may be produced in different colours and as no lacquering or other protective coating is necessary for aluminium parts, automobile interests are considering the material in the construction of light cars built essentially of aluminium and plywood.

Chrome-Nickel Steel

Improving its Acid Resisting Qualities

ACCORDING to an invention of K. M. Tigerschiöld, of Fagersta, Sweden, austenitic chrome-nickel steel can now be made more resistant to the attack of sulphuric acid by an addition of silicon and copper. The austenitic or austenite-martensitic alloy should contain 22 to 35 per cent. nickel, 0 to 3 per cent. chromium, 4 to 6 per cent. silicon, and 0.5 to 2.5 per cent. copper. The carbon content should be kept between 0.05 and 0.2 per cent., but can be raised to 1.5 per cent. when a particularly high wearing strength is desired. The nickel content can be replaced by cobalt. For certain concentrations of acid, part of the silicon is replaced by molybdenum, which can be present in amounts of from 0.2 to 10 per cent., independent of the silicon content. Small amounts of vanadium, titanium, tungsten, and manganese, and the ordinary impurities of steel can be present without interfering with the properties of the alloy. The alloy can easily be worked with cutting tools, and is recommended for containers, pipes, valves, and engine parts.

Aluminium in the U.S.S.R.

Recent Production Developments

THE production of aluminium is one of the new branches of industry created in Soviet Russia under the first Five Year Plan. The Krasnyi Vyborjetz plant in Leningrad yielded the first aluminium, from Tikhvinsk bauxite, in 1929. The alkaline method of obtaining aluminium oxide has been successfully applied at special test plants, and aluminium production is now on a commercial scale. The Volkhovsk combined works, which are the first aluminium works in the U.S.S.R., are at present partly under construction and partly working. The capacity of these is now being extended to 12,000 tons of aluminium per year as against 5,000 tons which was the estimated figure under the first Five Year Plan. The Dnieper aluminium plant at Kichkas (Ukraine) will have a still greater output. This plant when completed will produce 40,000 tons of aluminium a year. It will be the most powerful plant of its kind in Europe and second only to the Arvide works in Canada. The Dnieper plant will also treat Tikhvinsk bauxite. Most of the equipment for this plant is being made in the U.S.S.R., while the Volkhovsk works are entirely equipped with imported machinery. The construction of a large combined plant will be started at Sverdlovsk in 1934: this plant will probably produce 50,000 tons of aluminium metal a year. A test plant for extracting aluminium oxide from clay is reported to be constructed at Moscow. By the end of 1937, it is suggested that the aluminium industry of the U.S.S.R. will take the second place in the world after the United States.

Useful Data on I. C. I. Metals

WE have received two seasonable publications from I.C.I. (Metals), Ltd., in the form of a desk diary and a combined pocket diary and season ticket case for 1933. The desk diary includes full postal information, and the pocket diary contains a collection of useful data on metals.

Some Recent Metallurgical Patents

Acid Resisting Iron Alloys

ACID resisting iron alloys may contain 7 to 25 per cent. of nickel, 2 to 30 per cent. of chromium, 0.1 to 5 per cent. of tantalum, 0.1 to 4.5 per cent. of molybdenum, 0.1 to 2 per cent. of vanadium, and up to 1 per cent. of carbon. The molybdenum may be wholly or partly replaced by tungsten, and the tantalum partly by niobium. Titanium or zirconium may be added for purposes of deoxidation. (See Specification No. 383,364, of J. J. V. Armstrong.)

Heat Treatment for Alloys

NICKEL alkaline earth alloys containing up to 10 per cent. of the alkaline-earth metal and up to 1 per cent. of carbon can be heat-treated by rapidly cooling them from 750 to 1,350° C. and reheating to 380 to 600° C., preferably about 500° C. The alloys may also contain one or more of the elements aluminium, chromium, cobalt, iron, copper, managanese, silicon, tantalum, titanium, vanadium, tungsten, boron, cerium, molybdenum, zinc, and tin, the total amount of such elements not exceeding 45 per cent. (See Specification No. 382,573, of Siemens and Halske, A.-G.)

Beryllium Alloys

ALLOYS of beryllium with heavy metals, for example copper, nickel or iron, can be produced by the thermal reduction of beryllium compounds in the molten heavy metal by means of magnesium or a magnesium alloy, for example, an alloy containing 40 to 60 per cent. of aluminium. A mixture of the beryllium compound and reducing agent, preferably briquetted, is introduced into the heavy metal, or the beryllium compound is stirred into a melt consisting of an alloy of the heavy metal and magnesium, preferably under a flux. Excess of the reducing agent is removed by heating the melt to vapourise the magnesium. The reduction may take place in an atmosphere of hydrogen. (See Specification No. 383,200, of I. G. Farbenindustrie.)

Metallic Coatings

NON-METALLIC substances, other than rubber and products of cellulose esters or cellulose ethers, can be coated with metals by treating them with a reducing solution, the solvent of which gently swell the substance, without obstruction by the reducing agent, drying the substance with the reducing agent firmly embodied in its surface, and immersing the substance thus treated in a reducible metallic salt bath for the purpose of depositing firmly adhering metal thereon. Parts of the article which are not to be metallised are covered with a protecting coat of cellulose ester varnish or asphalt-lac, which is subsequently removed together with the superimposed metallic layer. Suitable substances for metallising are celluloid substitutes such as casein-, albumen-, phenol-, urea-, thiourea-, and formaldehyde condensation products. (See Specification No. 382,704, of M. O. Eschingen.)

Extraction of Aluminium

A NEW process for the production of magnesium consists in reducing at a high temperature magnesia, or dolomite, or a silicate or carbonate of magnesium by silicon and condensing the vapour produced. The reducing agent may be pure silicon or magnesium silicide or a high silicon ferrosilicon or any appropriate alloy of silicon which may be prepared by reduction of silicates by carbon in the electric furnace. A very intimate pulverised mixture of the magnesia containing substance and reducing agent is compressed and heated in a fireclay or iron retort communicating with an iron receiver in which the reduced magnesium condenses. The reduction may take place under reduced pressure or in a reducing atmosphere by passing a gentle current of hydrogen through the apparatus or preferably by maintaining in the apparatus a slight pressure of hydrogen or hydrocarbon. The residue of the reduction is a mixture of silica and magnesia which may also contain small quantities of magnesium silicide and silicon. By reducing this residue and an excess of silica by carbon in the electric furnace a mixture of magnesium silicide and silicon is obtained which may be employed for the reduction of a further quantity of magnesia. (See Specification No. 382,899, of G. Gire and R. Fouquet.)

Hard Alloys containing Titanium

HARD alloys may be formed of 50 per cent. or more by weight of titanium carbide with an auxiliary metal, for example, iron, cobalt, nickel or their alloys or alloys of cobalt, chromium, and tungsten with or without carbon. The titanium carbide may be supplemented by about 10 to 20 per cent. of other carbides such as tungsten, molybdenum or tantalum carbides. The pulverised carbide is mixed with the powdered auxiliary metal, pressed to form the final body and then heated to a high temperature preferably in hydrogen, or an inert atmosphere or *in vacuo*. The bodies may also be heated first to a moderate temperature to render them easily workable and then finished by heating to the high consolidation temperature. (See Specification No. 383,327, of Deutsche Edelstahlwerke, A.-G.)

Aluminium Silicon Alloys

ALUMINIUM silicon alloys containing 5 to 30 per cent. of silicon can be improved or modified by treating the molten alloy with mixtures comprising fluorides that *per se* are incapable of producing a modifying effect and alkali carbonates. Such stable fluorides comprise fluorides of alkaline-earth metals, aluminium, magnesium, heavy metals such as manganese, zinc, and double fluorides of alkali metals. The melting-point of the mixtures may be reduced by additions of salts or known fluxes such as alkali chlorides. Constituents of the alloys other than silicon, for example iron, copper, manganese, cobalt, etc., also become highly dispersed by the treatment. The process may be used as a pre-treatment to known modifying processes for example, after adding the reaction mixture metallic sodium may be added to the melt through the flux. (See Specification No. 380,577, of Light-Alloys, Ltd.)

Tungsten Carbide in Hard Alloys

HARD alloys for making toolbits, wire drawing dries, etc., can be produced by mixing a powder comprising tungsten carbide, with or without 3 to 20 per cent. of tungsten powder, with at least 20 per cent. of a metallic alloy which contains 50 to 85 per cent. of tungsten and one or more of the metals iron, nickel, cobalt, chromium, titanium, vanadium, molybdenum, and which after having been melted and solidified is finely pulverised. The mixture is formed to shape by pressing or otherwise, and sintered. In an example commercial tungsten and the auxiliary metal or metals are melted in a graphite crucible, poured on to a cool slab of carbon or graphite and pulverised. To prevent excessive absorption of carbon during melting, the auxiliary metal may be introduced in the form of oxide. The mixture is added to powdered tungsten carbide which may contain tungsten and sintered in an electric furnace. (See Specification No. 380,941, of E. A. A. Gronwall.)

Production of Alloy Steels

STEEL containing nickel, particularly stainless steel, can be made by introducing into a steel bath molten nickel which has been produced by heating nickel matte with silicon or a silicon alloy in the presence of a basic slag. The reduction of the matte may take place in the presence of the steel bath and the reducing agent, which should be substantially carbon free, may be commercial silicon, ferrosilicon, or a silicon alloy containing a metal to be alloyed with the steel, for example, nickel or chromium. If nickel-silicon, or ferro-nickel-silicon is used to reduce the matte both matte and reducing agent will contribute nickel to the steel. In making stainless steel, chrome ore, nickel matte, and reducing agent, in admixture together, or in two separate batches, of reducing agent with chrome ore and nickel matte respectively, are charged with lime, fluorspar and other fluxes into an open arc electric furnace. The slag is removed and low carbon ferro-manganese is added to the steel, after which a finishing slag comprising lime and quartzite is formed. The steel is worked under the slag to which small additions of ferrosilicon are made until metal and slag are deoxidised, and is then tapped into a ladle, treated with 0.25 per cent. of silicon (as 50 per cent. ferrosilicon) and cast. (See Specification No. 382,754, of Electro-Metallurgical Co., New York.)

Metallurgical Section

March 4, 1933.

Aluminium in Brass Alloys

SEVERE criticism has been directed at the presence of aluminium in brass alloys, and yet when present in the correct proportion, as determined by the general composition of the brass, use and mechanical treatment involved in finishing the castings, it has already been pointed out that aluminium is an especially useful addition agent. The harmful properties brought to notice have been traced to the formation of aluminium oxide, and this material results from improper methods of melting and treating the brass while in the molten state. A very important field of application of such aluminium brasses has been created by the pronounced increase of resistance against corrosive influence induced by the aluminium. Where the brass contains other constituents such as iron, the effect of adding aluminium is to decompose iron carbides which have been formed by the interaction of iron constituents with the carbon derived from combusion gases, crucibles, etc., giving a perfect solution with the consequent elimination of electrically-opposed constituents which have a tendency to cause corrosion by their galvanic effects. At the same time the decomposition of iron carbide reduces hard spots and improves machining qualities of the alloy. In addition, the strongy de-oxidising action of the aluminium also plays an important rôle, as the oxide content of brass allys induces galvanic effects in the presence of active corrosion agents. In another direction, the addition of aluminium to brasses which are rich in zinc notably increases the fusibility of such alloys. For instance it is almost impossible to cast complicated and sharply-defined shapes from brass alloys rich in zinc unless aluminium is added in amounts up to a maximum of 0.5 per cent. Still another advantage is offered by the addition of small quantities of aluminium for the purpose of eliminating zinc vapors during casting operations, especially where the alloys are also rich in zinc. Brass containing 38 to 40 per cent. of zinc invariably emits dense vapours when it reaches the usual casting temperature, but the addition of 0.3 per cent. of aluminium proves very effective and and may reduce the vapour to a mere haze. The characteristic influences of metallic aluminium upon the properties of brass alloys were dealt with by Genders at the Spring Meeting of the Institute of Metals, held in London, 1930, and also came in for consideration by a Special Committee appointed by the German Institute of Metals which published its conclusions in 1929.

In producing aluminium brass direct from virgin metals a serious error is often committed by relating the de-oxidation process to the end of the melting period, taking it for granted that the virgin metals are free from oxide and that aluminium oxide produced by the oxide content of the copper will be taken care of by the de-oxidation agent. Virgin copper, it will be recalled, usually contains cuprous oxide, which may vary from very small amounts in the electrolytic product to as much as 0.4 to 0.6 per cent. in the furnace refined product. If, therefore, zinc or aluminium are added to molten furnace refined copper, the cuprous oxide which is present will be converted into zinc oxide or aluminium oxide, as both of these two metals exert a greater affinity for oxygen than does copper. Before adding the zinc or aluminium, the melted copper should therefore be de-oxidised by adding phosphor copper or a similar agent. The absorption of aluminium oxide skins and particles by the metal in the process of casting can be avoided if care is exercised in pouring, for if no agitation is caused the dross which is formed will remain at the surface of the castings where it can be easily removed in the subsequent machining. Agitation causes the oxide skin to break with the result that it is carried to the interior of the casting and a new skin immediately forms. Where brass scrap is used it is essential to remove any aluminium brass scrap which is liable to be present, as the formation of dross will be unduly increased.

A Case for the Electric Furnace

THE melting of aluminium or its alloys in furnaces where there is more or less direct contact with flame, or where the furnace atmosphere containing hydrogen, still gives the possibility of a serious amount of gas being taken up by the molten metal. It is true that the presence of a continuous film of oxide on the surface of the metal retards the process of absorption, but during the manipulation of the charge this skin is repeatedly broken. It is here, therefore, that a wider adoption of the electric resistance furnace could do much to eliminate the troubles of the general aluminium founder. For the de-gassing of aluminium there are methods available which prove to be successful on a manufacturing scale, but do they not complicate the actual production process? If the metal is primarily prevented from coming into contact with deleterious gases it would surely be the most direct path for the producion of a gas-free meal such as the founder needs. The founder is dependent upon supplies of raw aluminium and hardening alloys, but if these products are rich in hydrogen it becomes difficult to obtain good castings without adopting some de-gassing process. Special precautions ensuring the supply of gas-free metal by the actual aluminium producers must necessarily increase the cost of the materials supplied to the founder, but it seems probable that if electrical melting was adopted generally there would be a tendency to produce metal

with the lowest gas content, which might, moreover, be relatively constant. At present it is undoubtedly due to existing manufacturing conditions that the gas content of different brands of metal varies considerably, even in consecutive batches obtained from the same source. The real merit of the electric furnace does not seem to be appreciated to the extent that it deserves in connecion with its outstanding feature of absence of hydrogen, a gas which seems to be the chief offender in aluminium founding troubles. Even when the cost of current is higher than fuel for a furnace of the ordinary type, the advantage of obtaining gas-free metal should outweigh the difference in working costs. Furnace linings, it is true, might still give cause for anxiety, as refractories which contain siliceous material are rapidly eroded where fluorides are present in the fluxes employed. As an alternative, magnesia bricks, although considerably more resistant, are sensitive to rapid changes of temperature with the ultimate result that spalling might occur.

Treatment of Aluminium Scrap

In the re-melting of aluminium it is common practice to use protective slags consisting principally of salt mixtures. The temperature of melting, however, has to be kept low in order to minimise gas absorption, and for this reason the slag should be selected for its lowest possible melting point adding the desirable feature of being capable of dissolving oxides to a relatively high degree. Sodium or potassium chloride, two of the cheapest materials available, cannot be used alone because of their high melting points, and it therefore becomes necessary to use mixtures of salts. Investigations on this subject have recently been placed on record in "Metallwirkschaft," December 23, 1932. Using small quantities of aluminium powder and different salt mixtures, the best results seem to have been achieved with binary mixtures containing barium chloride, sodium chloride, potassium chloride, sodium fluoride, and cryolite. With these the aluminium formed a proper reguline mass, well protected by the salt slag coating which acted as a gas trap. The alkali metal salt mixtures approached nearest to the desirable low melting point, 653° being reached with about 20 per cent. of sodium fluoride to 80 per cent. of potassium chloride.

Blast-furnace Reconstruction

The construction of blast-furnaces is an expensive undertaking so that it is not surprising to find financial difficulties during the last few years have retarded the development of pig iron production. Dorman, Long and Co., however, have now decided that the time is opportune to embark upon the reconstruction of the blast-furnaces at their Cleveland works. The new type of furnace to be adopted will enable substantial economies to be effected in working costs. For some time past this firm has been carrying out extensive and prolonged investigations so that they may find the most economical unit for producing basic iron for steel making, having in view the utilisation of as much Cleveland ironstone from their own mines as possible. The conclusion which has been reached is that a mechanically-charged furnace producing about 400 tons of iron per day is the best unit for their conditions. At their Cleveland works, South Bank, there are two skip hoist mechanically-charged furnaces for an output of about 200 tons per day, and one of these units is to be reconstructed to increase the output to 400 tons. The main alterations are an increase in hearth diameter from 12 to 16 feet, necessitating an increase in column centres and the provision of a larger bosh. The furnace will be blown independently by a new turbo blower fitted with constant volume control. Modifications will be made to the furnace top gear and four gas offtakes of modern design will be provided in order to ensure a uniform gas flow and even working of the burden. The stack will be water-cooled. Such improvements in style design have been achieved recently, when using cleaned gas, as will enable the furnace to operate on a two-stove basis—one stove on gas and one on blast. A third stove will be available as stand-by. With these large outputs it is also very important to crush and grade the ironstone, and a plant will be installed for this purpose. The work of reconstruction has commenced, and it is hoped will be completed in about eight months. The furnace will be put in blast as soon as it is ready and when tested the reconstruction of further units will be taken in hand giving the Cleveland works a complete iron and steel equipment of the most modern type.

Phosphorus in Metallurgy

Erratic Behaviour in Coke, Iron and Steel

Researches into the problem of phosphorus in the production of iron and steel were considered at a meeting of the West Cumberland Society of Chemists and Engineers, held at Workington, on February 24, when papers were read by Dr. G. G. Slottman, Mr. A. Dodd, and Mr. A. G. Hock.

Mr. Dodd dealt with the determination of phosphorus in coke and reviewed the methods and principles of investigation regarding the presence and effects of the element. Dr. Slottman's remarks were of similar nature. He referred to the fact that the qualities of ore in different localities had considerable bearing on the operatinon of blast furnaces throughout the world and said that the tremendous increase in the number of plants in Cumberland was due to the fact there were few ores with a less phosphorus content than that obtained within the county. The hematite iron ores in Cumberland were being utilised more and more for the manufacture of special irons and steels. Speaking on phosphorus in steel, Mr. Hock said it was very difficult to determine accurately the effects of the element as there were so many factors responsible for the texture of steels. It had been difficult to get any two experimenters to work under precisely the same conditions. Thus it was only by wading through the results obtained in the past that an adequate idea of the effects of phosphorus could be obtained. Its properties in very low carbon steels were accurately known, but when it came to complicated alloy steels they had to proceed by induction.

Manufacture of Nickel and Nickel Alloys

A booklet giving particulars of the various operations involved in the production of nickel and nickel alloys, together with data on the properties and uses of these materials, has been published by Henry Wiggin and Co., Ltd. This booklet runs to 40 pages, and is profusely illustrated. We notice that the nitrogen and hydrogen for use in the non-oxidising annealing furnaces are produced in special equipment. The principle employed in the nitrogen plant is that of liquefying air, which enables practically pure nitrogen to be extracted from the atmosphere, leaving a rich oxygen-containing mixture which may be used for other purposes. The nitrogen is delivered by compression to the gasholders, from which pipe lines are taken to different parts of the plant as required. The plant for producing hydrogen is essentially an enlarged type of laboratory apparatus in which hydrogen is produced by the reaction of caustic soda solutions on crude metallic silicon.

Monel Metal and Pure Nickel

Their Properties with Reference to Chemical Plant

The following notes are based on information supplied by Henry Wiggin and Co., Ltd., whose business now incorporates that formerly carried on by Monel-Weir, Ltd.

NICKEL and Monel metal are engineering metals which combine mechanical characteristics of the order of those of mild steel, with a high degree of corrosion resistance, a silvery appearance of some æsthetic value and favourable working properties. Nickel is used in the chemical process industries under conditions where corrosion resistance and freedom from contamination of the product by harmful metals is desirable: nickel equipment is therefore used in handling caustic soda, photographic emulsions, perfumes, cellulose acetate, pharmaceuticals and numerous food products. Monel metal (a nickel-copper alloy containing approximately two-thirds nickel and one-third copper, with a small, carefully controlled, quantity of iron, manganese and carbon), on the other hand, probably offers a useful resistance to a wider range of corrosive conditions than any other alloy. In addition to its valuable corrosion-resisting properties, it possesses great strength, resistance to abrasion, impact and fatigue, and retains a marked proportion of its strength at elevated temperatures.

By courtesy of The Aluminium Plant & Vessel Co., Ltd.

Nickel Coils for use in Alkali Plant

Neither Monel metal nor nickel is appreciably corroded by the atmosphere, even by the rather impure form found in industrial centres. Both are almost completely resistant to the action of alkalies and they offer a useful resistance to the commoner commercial acids, with the exception of nitric acid and sulphurous acid, at the concentrations and strengths usually found in industry. Owing, however, to the fact that so many variables enter into corrosion problems, it is seldom possible to state definitely that a certain metal will resist a definite set of conditions. Tables showing loss in weight with various strengths of stagnant acids are of little commercial value for they ignore the more important variables such as degree of aeration, temperature and degree of agitation. Industrial experience is the better guide to the value of metals in chemical works, for which reason it is more convenient to describe the action of nickel and Monel metal under the headings of the commoner commercial products with which they are used.

Sulphuric Acid and Hydrochloric Acid

In acid exposure some action on Monel metal is invariably to be expected, but the action is, in general, markedly less than with other engineering materials. Acid concentration, temperature and degree of aeration are the most important factors determining corrosion rates: the nature of the acid, in the case of the stronger acids, being less important. Rates increase with aeration and, for any one acid, with hydrogen ion concentration. Air-free acids, other than those of an inherently oxidizing character, like nitric, do not corrode Monel metal, but with acid solutions having a considerable dissolved air content the corrosion rates are higher, and in the case of the stronger acids, attack may be pronounced. Acids at boiling temperature are commonly three or four times more corrosive than acids at room temperature.

Nickel possesses a good resistance to the non-oxidizing group of acids, hydrochloric, phosphoric, acetic, tartaric, etc. As with Monel metal, aeration and higher temperatures are accelerating conditions; in some cases solutions at temperatures approaching boiling point are too corrosive to make the use of nickel practicable. Against inherently oxidising acids, such as nitric acid and frequently chromic acid, neither Monel metal nor nickel shows useful resistance.

Monel metal is suitable for sulphuric acid concentrations up to 80 per cent., and is widely used commercially in contact with this acid. Though less resistant than lead and silicon-irons, Monel metal is definitely advantageous from the standpoint of mechanical properties. Furthermore, the fact that it lends itself to normal fabricating operations makes it preferable to the silicon-irons, which are brittle and too hard to machine. Monel metal in quiet exposure to sulphuric acid shows corrosion rates around 0.004 in. per year, increasing with aeration to 0.020 in. or 0.030 in. per year in 5 or 10 per cent. solution. With stronger (up to 80 per cent.) or less dilute solutions the rates are rather less.

Nickel is one of the best materials to employ in contact with hydrochloric acid solutions, although this does not necessarily mean that its resistance is of a very high order, for hydrochloric acid is one of the most difficult of all acids to handle. From the practical standpoint nickel can be considered resistant to hydrochloric acid at room temperature up to about 15 per cent. concentration, under conditions where the acid has a low air content, *e.g.*, quiet submerged exposure. The acceleration of attack with increase in temperature, concentration and aeration is fairly rapid, although in many commercial operations the penetration only amounts to 0.015 to 0.030 inch per year. Monel metal may be used in concentrations up to about 5 per cent. in relatively quiet exposure (0.01 to 0.02 inch per year); higher concentrations are strongly corrosive. Nickel is better than Monel metal with hot or strongly aerated solutions over 1 per cent. hydrochloric acid. Monel metal is employed for the linings of bubble towers where hydrochloric acid is formed, as steel is badly attacked under such conditions.

Monel metal is suitable to use with pure phosphoric acid solutions at ordinary temperatures. Hot solutions are naturally more corrosive. Most process solutions are corrosive because they contain iron, nitrates and chlorides. As a rule it is not safe to use nickel with process phosphoric solutions, as these often carry iron salts that are strongly corrosive to nickel. Thus, at 176°F., a dilute solution of phosphoric acid, carrying 0.40 per cent. iron, corroded nickel at a rate of 0.80 in. per year. In the absence of iron, phosphoric in the cold has low to moderate action on nickel, but hot concentrated solutions are definitely corrosive.

Nickel and Monel metal both exhibit a reasonable resistance to cold acetic acid at concentrations ranging up to 20 per cent., nickel generally showing a resistance rather superior to that of Monel metal. Monel metal pumps handling acetic acid solutions have given excellent performance. With higher concentrations and temperatures, particularly in the presence of strong aeration, nickel and Monel metal are generally unsuitable. The behaviour of nickel and Monel metal in contact with other organic acids, such as citric, tartaric, malic, formic, lactic and oxalic, is similar to their behaviour in contact with acetic acid. It is noteworthy that Monel metal has proved highly satisfactory for the construction of rotary dryers for tartaric acid, and for the crystallising tanks and transport trucks for citric and tartaric acids.

Action of Salt Solutions

Monel metal is being used to handle solutions of salts like sodium chloride, notably for rotary dryers and evaporators in the production of common salt, for pump parts in the handling of brines and for mesh screens in the grading of a large range of crystalline salts. Corrosion rates are negligible and local action is very uncommon. The air content, of course, affects the absolute corrosion rate, but even with complete air saturation the corrosion rate is very low for practical purposes. Acid salt solutions, such as aluminium chloride, are somewhate more corrosive, and solutions of ferric, stannic and mercuric salts are inclined to be very corrosive. The common alkali salts, with the exception of hypochlorites, have usually no effect. Nickel has a high degree of resistance to solutions of the alkaline and alkaline earth and related salts, such as the chlorides, carbonates, sulphates and nitrates of sodium, calcium, zinc, etc.

Both nickel and Monel metal are extremely resistant to caustic alkali solutions, such as sodium and potassium hydroxide, and sodium carbonate and bicarbonate. Evaporators made throughout of nickel are employed in the production of high grade caustic, this being particularly advantageous where " free from iron or copper " specifications have to be met.

Ammonia Oxidation

In ammonia oxidation processes, pure nickel is used for all pipes and parts handling the hot ammonia prior to its reaching the converter body. The reason why nickel is used is because it shows no tendency to crack to ammonia, while it possesses adequate strength to carry the pressure and working temperatures involved. Pure nickel is used also for the gauze holders supporting the catalyst. Monel metal and pure nickel are practically immune from attack by anhydrous ammonia in refrigeration plants; therefore Monel metal valve spindles and pump rods are highly satisfactory in ammonia circuits and compressors. Ammonium hydroxide in process solutions in many cases falls within the range for which pure nickel is suitable. Nickel is generally considered to be more suitable than Monel metal for handling ammonia, but in the drying of sulphate of ammonia, Monel metal is an established material for centrifugal baskets and linings, and also for mesh band conveyors.

Monel metal retains a marked proportion of its strength at superheat temperatures up to 800°F. and is highly resistant to the corrosive and erosive action of impure steam. For valve parts, orifice plates, nuts, bolts, studs and other equipment exposed to or used in the control or measuring of superheated steam, Monel metal is an established material. It is outstandingly serviceable for turbine blading which has to operate under difficult conditions.

Nickel is widely used in handling caustic fusions, particularly in laboratory work. The use of nickel caustic pots is not practical if the caustic carries sulphur, as the latter causes rapid attack. Among the fusions that attack nickel relatively rapidly are silver chloride, potassium bisulphate, vanadic oxide, borax and, as a rule, cyanide. Chlorinated hydrocarbons in general are also well resisted by nickel, though in the presence of moisture som corrosion may occur. Nickel is well suited to the construction of rectifying equipment for carbon tetrachloride and similar solvents in the dry cleaning industry. Monel metal is commonly employed for the construction of dry cleaning machines and filter cloths operating in contact with these solvents.

Nickel develops a protective oxide in pure oxidising atmospheres and has given long service up to 650/700° C. High manganese-nickel is resistant to attack by burning gasoline and other engine fuels, and is employed for spark plug electrodes and ignitor tubes. Manganese-nickel alloy is used also for fire-brick stay-bolts. The upper useful limit for Monel metal in oxidising atmospheres is 500°C. The presence in the atmosphere of sulphur dioxide somewhat lowers the useful range. Monel metal has successfully met the requirements of nitriding equipment involving contact with ammonia, hydrogen, and nitrogen at about 550°C. It also finds wide use in the glass industry.

Steel Industry Developments

An Instance of the Promotion of New Industry

THE decision of Stewarts and Lloyds, Ltd., to erect a large scale Bessemer steel plant at Corby was referred to by Dr. E. L. Burgin, Parliamentary Secretary to the Board of Trade, at the annual dinner of the National Federation of Iron and Steel Manufacturers held in London on February 23. He said it was an instance of helpful new industry promoted and sustained by the aid of capital contributed through the Bankers Industrial Development Co. A somewhat similar reorganisation was evidenced in the case of the Lancashire Steel Corporation, Ltd., and the amalgamation of well-known companies in Lancashire, now comprising the main part of the iron and steel wire industry. "There never was a time," said Dr. Burgin, " at which capital expenditure on building, planning, re-conditioning and re-equipping factories could be spent to greater advantage."He added, " the large decline of imports of Continental steel from the moment of the announcement of the two years' extension of protection is a striking proof of the effect of measures taken in time, and will be a bulwark behind which you will make your own efforts at reorganisation. Negotiations are being conducted by the Board of Trade with many countries, and in all those negotiations iron and steel in their various forms take a prominent place."

Mr. Charles Mitchell, chairman of the National Committee for the iron and steel industry, said the National Committee and the various committees associated with it, which had been engaged during the past few months in hammering out a national policy having for its objective the restoration of employment in the industry and ultimate prosperity, were making real and effective progress in a very difficult task.

Mr. E. J. George, of the Consett Iron Works, Durham, the new president of the Federation, presided over the dinner, and the large attendance included many representatives of the iron and steel industries. Mr. Runciman, the President of the Board of Trade, was prevented from attending by the death of his mother, and Lord Hewart, the Lord Chief Justice, who was to have replied to the toast of the guests, was kept away by a cold.

Empire Development and Research

THE January issue of the " Bulletin of the Imperial Institute" contains a report on the Java fibre industry by E. F. S. Shepherd, Mauritius Department of Agriculture, wherein it is stated that sisal is replacing cantala, since the fibre produced by the former is of superior quality. Another article on " Unvulcanised Rubber Powder," by G. Martin, deals with the difficulties in the use of rubber powder, and its superiority over substitutes. The production and cultivation of geranium oil in Algeria and California, and the use of producer gas as a fuel for motor vehicles are other features of interest. In addition there is the usual valuable bibliography on plant and animal products.

The Smelting of Complex White Metal Residues

Difficulties Overcome by Present-Day Technique

In view of the complex nature of white metal residues, the processes employed for reclaiming and the recovery of the constituent metals entails a wide knowledge of the different branches of smelting metallurgy. The term " white metal residues " embraces wastes and by-products from the working of white bearing metals, anti-friction metals, solders, pewters, type metal and alloys composed principally of tin, lead, antimony, and copper.

As a result of the system of affinities which the different metals possess for oxygen, their varying specific gravity, and effect of different temperatures, the skimmings, etc., removed from these metals comprise a wide variety of compositions. Apart from the large number of alloys which are treated, there are the skimmings, drosses and ashes withdrawn from molten surfaces at different stages. The result is that a multifarious collection of odd lots of material have to be handled according to physical condition and chemical composition. At one time borings, millings, filings and sweepings of these metals were melted directly in a bath of molten white metal suitably prepared, but losses due to oxidisation caused this system to be abandoned. Reclaiming work in past years was often of doubtful value as the earlier refiners were trained more in metallic alloying, direct fusion methods, etc., and not in high class smelting practice. By introducing some of the systems adopted for handling complex tin ores and antimony ores, much greater scope has been offered, but it should be noted the success of this work rests in the systematic working off of one waste product against another. Failing this, the number of products and by-products would be increased indefinitely.

Preliminary Operations

Preliminary operations consist in sorting out the materials. Selected compositions are accumulated in " bins," the analysis of the composition being recorded upon the outside of the wooden partitions. First skimmings removed are especially rich in tin, second skimmings are rich in antimony, whilst final skimmings show a preponderance of lead. There are, of course, innumerable intermediate compositions, whilst by altering the system, the first skimmings may be richest in lead, and the final dross rich in tin. The order of skimming is dependent on the system employed apart from the order of affinities, and specific gravity, whilst still further, the order of affinities may be altered by suitable fluxing, and metallic precipitation, both direct and indirect. Skimmings rich in metallic constituents are kept apart from those of the same approximate composition, but which are more or less converted to an oxidised condition. The different accumulations are then removed from the " bins " to meet the requirements of any particular charge which is being worked.

In the ordinary way, rich metallic skimmings and drosses are first sweated or liquated so that the metallic values may be recovered as far as possible, but this can only be carried out successfully if the materials are free from chlorine or constituents which would involve a premature loss. Whilst some systems permit sweating as a preliminary treatment, the most economical method consists of washing out the soluble contents and thus eliminating chlorine, etc. The residues are examined by analytical methods for the approximate tin and chlorine content, and should much of the latter be present, the charge is temporarily laid aside for washing purposes. Washing is conducted by merely stirring up the material in a large tank of water, when tin chloride and zinc chloride are dissolved; lead chloride remains insoluble, but is seldom present in sufficient quantity to justify treatment with hot water. The supernatant liquors are syphoned into another tank and several shovels of sodium sulphide are added. After settling the clear liquor is removed and the precipitate is treated with dilute hydrochloric acid, provided economical conditions permit, the zinc sulphide is decomposed and dissolved. The precipitate which now remains is mostly tin sulphides, together with a small proportion of lead sulphide. The wet precipitate is placed on an open iron plate arrangement directly over a coal fire, and roasted with occasional hand stirring until free from sulphur.

The roasted mass is similar in composition to that of thin pan scum, which is the lighter oxidised yellow material removed from the pans; it is mixed with this, and also with residual ashes from liquation operations. After fluxing, this mixture is transferred to a water-jacketed blast-furnace and smelted. The washed residues are dried by simply spreading them out upon a stone-flagged floor overnight. In some cases they are placed on the top of a hot flue where waste heat is utilised, but if this heat is not controlled there is a risk of the tin liquating when rich ashes are handled.

Furnace Design

The success of the sweating operation is largely influenced by the design and general construction of the liquating furnace. Up to within the past twenty years these hearths were fired almost exclusively by coal, but to-day the best designs are oil-fired; efforts have also been made to introduce gas-fired, and even coal-fired hearths using pulverised fuel. As a general rule, it is only those residues which are rich in " metallics " which are sweated; the highly oxidised varieties are more effectively dealt with in reverberatory furnaces or blast-furnaces. Where such material has to be liquated, it is customary to have at least two sweaters, so that discrimination can be made between those by-products which are rich in tin and those poorer tin classes, *i.e.*, rich in antimony, lead, etc. The type of furnace generally used resembles a small reverberatory, in which the bed inclines downwards from grate to well at the flue end. At one time firebrick only was used since it was contended that this was more than sufficiently refractory for all purposes to which the hearth would be subjected. The strong penetrating influence of antimony, and its compounds, however, have caused basic beds to be preferred. The well of the hearth is lined with chromite on top of the magnesite, whilst the remainder of the inner lining is made almost entirely of magnesite. The mortar used for the bricks is merely ground magnesite bricks and dilute hydrochloric acid mixed to a paste. Should the hearth be required principally for reverberatory smelting, dolomite mortar is preferred.

From practical experience it has been shown that chromite represents the most satisfactory material as a receptacle for molten antimony oxides, etc., whilst magnesite serves quite resistant to the corrosive fumes. The well of the hearth is furnished with a tap hole, which permits of the metal being run out periodically, passing into a small kettle which is heated by its own fire. The oil firing is so done that the drosses, etc., are raised to sweating point by means of low velocity flames. The fuel-oil enters the furnace by way of a burner provided with a nozzle so that the spray of oil takes the form of a ferrule in its passage towards the far end of the hearth. Maintaining a reducing atmosphere is a simple matter; the temperature of the furnace may be very accurately controlled by increasing or decreasing the pressure on the oil pumps. The damper in the flue is also constructed for accurate adjustment, as there are occasions when the smoky gases escape too readily, and do not ensure a sufficiency of tangible carbonaceous matter to exert a strongly reducing influence. With the older coal-fired sweaters, it was necessary to select splint coals and admix a shorter flame producing coal. Anything in the nature of oxidising influence is detrimental to the success of this work, as tin and its associated metals are too easily reverted to the oxidised condition.

The Sweating Process

With the modern oil-fired liquating furnace, the difficulties previously encountered in accurate sweating operations have largely disappeared, and stirring may be done continously, if desired, as this greatly accelerates the process. The charge, which is made up of skimmings, rich drosses, etc., all of which converge on the same general composition, is first mixed with a small proportion of coal dross. The proportion of coal dross usually averages about ten per cent., but this figure requires varying according to the class of material handled. The furnace gases are not allowed to pass to the fume collectors, as furnace control is usually relied on to keep volatilisation losses to a minimum. With a very " leady " charge, any odd tinplate scrap on hand can be slowly disposed of, but the quantity of iron, and size of pieces thus added must be done in conjunction with the nature of the subsequent

blast-smelting process. For ordinary sweating, no fluxes are added, and no slags are produced. There are, however, exceptions with material of unusual physical condition, where it is necessary to add some inert substance to expose the "metallics" to best advantage.

After spreading the mass in an even layer across the hot bed of the furnace, the damper is carefully adjusted. When most of the metallic constituents appeared to have been sweated out, at this juncture, in the old system, the residual ashes were drawn out on to the floor, whereby they cooled down prior to being transferred to the ordinary reverberatory hearth. In the modern process, with improved furnace design, when once the metallic values have been separated from the dross the remainder of the charge is raised to a higher temperature by increasing the oil pressure. The reducing conditions are still maintained, but a larger volume of flame is introduced. Slag-forming materials are added, and mixed into the sticky mass by means of the stirring arrangements already mentioned. When the temperature is raised, the slag-forming fluxes commence to convert the mass into an agglomerated condition, in which form the residual ashes are most suitable for blast-smelting. With rich material the work is carried out on the same lines as that of reverberatory smelting, and the products comprise a slag for the blast furnace and an alloy more crude in composition than that obtained from the sweating operation. This crude composition is the result of adding iron, as tinplate and other "barren" waste materials.

Treatment of Rich Ashes

There are exceptions when it is desired to completely smelt out rich materials rather than risk a loss in the blast-furnace where the charges worked are comparatively large. By the addition of expensive fluxes, all material other than metal can be converted into an easily melted, thin and fluid mass, and practically every metallic constituent is caused to sink to the well of the furnace by virtue of its higher specific gravity. On the other hand, all impurities in the form of foreign metals are also caused to drop. A recent innovation, however, has demonstrated that impurities may be fluxed in the ordinary way, after which the "thinning" slag can be made to intermingle mechanically whereby only metal in the already metallic condition is permitted to sink. The system of conducting the operations largely rests on the value of the residues handled, since the fuel costs of oil-fired reverberatory smelting is much greater than that of reducing directly in the blast-furnace. Rich tin charges are, therefore, worked as far as possible by liquation, then by reverberatory smelting, and only the slags go to the blast process. Charges containing a moderate amount of tin are liquated, and the residual ashes are merely agglomerated so that they are raised to a suitable condition to permit successful blast-smelting. Poor ashes which are obtained from makers of lead foil, tea lead, metallic packing, etc., and contain comparatively little tin, are sometimes sweated only, since the residual ashes are of too little monetary value to justify agglomeration and blast-smelting. Rich antimonial charges appear to sweat most readily, and are sometimes admixed to more refractory forms of residues.

The metal which collects in the well of the sweater is tested both physically and chemically, sampling being performed with due caution in view of the variation caused by liquating phenomena. The surface of the metal is protected from oxidising influences by a layer of waste grease material, and although the latter tends to burn off, a layer of carbon is generally left which maintains the desired reducing action. Uncertainty on the selection of these greases at one time caused considerable trouble; oak bark, fine cork, and sawdust, although amply affording a means of protection, unnecessarily result in a temporary loss of metal, as the solid carbonaceous particles adhere firmly to the surface-metal and when skimmed can easily remove some of the metal.

Separation Principles

The metal from the sweating furnace is subjected to a somewhat protracted form of separation, in order to convert it to the most readily marketable alloy. In many cases, a sufficient stock of prepared tin and antimony alloys have been accumulated, and there is little option but to proceed with the complex separation and refining of the individual constituent metals. A variety of furnaces have to be engaged for this work, whilst assistance has sometimes to be invoked from the simpler wet methods of separation, and electrolytic extraction. As a general rule, the wet systems are more expensive, they are compartively slower, and require larger plant. Whilst water and drainage arrangements are usually provided for to meet the needs of the concentration tables, extension of the work to chemical extraction practice necessitates pumping systems, filter pressing, drying, etc. Extraction by electrolysis is only used as a last resort, although electrolytic refining of tin at the final stages is now becoming popular.

For dry separation there are innumerable small processes, and the hearths and plant required to meet them often have to be specially designed. The working costs are chiefly those of labour and fuel; expensive fluxes are employed only in exceptional circumstances. It is usual to draught out a programme of work so that a set of furnaces is kept in constant operation, fully occupying the furnacemen and using a minimum of fuel with the least fettling. Occasionally it happens that a demand is made for some particular alloy, and smelting is then suitably altered to meet this. In some cases the work may be considered as a study of specific gravities, whilst in others it is a study of relative fluidities.

Steel-makers' New President

AT the annual meeting of the National Federation of Iron and Steel Manufacturers held in London on February 23, Mr. James Henderson, deputy chairman and general manager of the Frodingham Iron and Steel Co., Ltd., was elected president for 1934. The following vice-presidents were also elected:—Sir John Beale, chairman of British (Guest, Keen, Baldwins) Iron and Steel Co., Ltd.; Captain R. S. Hilton, managing director of the United Steel Co., Ltd.; Mr. Charles Mitchell, chairman of Dorman, Long and Co., Ltd.; and Mr. Ben Walmsley, a director of Dorman, Long and Co., Ltd. Mr. Henderson is chairman of the Iron and Steel Industrial Research Council and also a member of the Advisory Council of the Department of Scientific and Industrial Research.

New Steel Produced by Dorman, Long and Co.

THE successful production of a new and improved quality of structural steel, to be sold under the name of "chromador" steel, is announced by Dorman, Long and Co. It has been evolved as the result of nearly ten years of continuous research at the company's Middlesbrough research department. Chromador steel is said to be a high tensile steel suitable for all structural purposes. It has at least 50 per cent. greater strength than the usual quality, with much greater resistance to corrosion, whilst its price is only 20 per cent. in excess of that of mild steel.

China Clay–Alumina Crucibles

IN the "Chemiker-Zeitung," of February 11, 1933 (page 116), Ruff and Bretschneider outline a new method of crucible manufacture in which a slip composed of a mixture of alumina and kaolin is baked at a maximum temperature of 1,650° C. Commencing with aluminium hydroxide (produced from bauxite by the Bayer process of caustic soda treatment in an autoclave), alumina is produced by ignition in a muffle for one hour at a minimum temperature of 1,000° C., and incorporated with hydrochloric acid solution and china clay by grinding in a ball mill. After evaporation to a suitable consistency over a direct flame, the slip is cast into plaster of Paris moulds and dried in several stages at a temperature gradually attaining the maximum of 1,650° C. Crucibles obtained by the new process are said to be non-porous and highly resistant to temperature changes.

Canadian Iron and Steel Production

THE Dominion Bureau of Statistics at Ottawa reports a production of 6,731 tons of pig iron in Canada in October, a total 15 per cent. in excess of that for September, and being the first gain in output since March. The output of steel ingots and direct steel castings totalled 17,102 tons in October, a decline of 26 per cent. as compared with the September total of 23,139 tons.

Metallurgical Section

April 1, 1933

New Knowledge in Non-Ferrous Metallurgy

At the recent annual meeting of the Institute of Metals, Mr. N. P. Allen gave some interesting information on the distribution of porosity in copper ingots. He conducted his investigations by means of systematic density determinations throughout the ingots, and in the course of this work examined high-conductivity and arsenical-copper, cadmium-copper and deoxidised copper, certain arsenical copper ingots cast under pressure also being studied. In the case of a high-conductivity tough-pitch copper billet, although there was a general increase of porosity from bottom to top, the lines of equal density ran vertically showing that it was the flow of heat outwards through the mould walls which determined the distribution of porosity, rather than the upward rising of free gas bubbles. Skin porosity was found only on the sides of the ingot and not at the bottom. As the sides of the mould, in this case, were of cast iron and the bottom was of copper, an ingot cast in a solid copper mould was subsequently examined. Here there was a certain amount of correlation between the structure and the density distribution. The skin was the soundest part, but the growth of columnar crystals appears to have been accompanied by selective freezing and segregation of the gases towards the centre. Further ingots were studied to observe the effects of overheating during melting and of reactions at the mould surface, the ingot material being 1 per cent. cadmium-copper. Here the general effect of over-heating was to seriously increase the porosity and to render variations in the ingot, from top to bottom, more marked. The most remarkable fact brought to light was the extraordinary unsoundness of the skin of the ingot when an oil dressing was used, an ingot cast without oil in the mould dressing showing no trace of this unsoundness. Apart from complications due to unsoundness caused by the mould dressing, the lines of equal density ran parallel to the probable direction of the isotherms in the cooling ingot, and this suggests that heat flow was the main factor in the distribution of porosity of the type found in these ingots. Porosity in copper ingots, considered generally, may be due solely to impurities present in the metal before teeming, or due in part to impurities taken up during or after teeming. Examples of the latter are mould dressing unsoundness; top surface unsoundness, as found in deoxidised arsenical copper ingots; and patchy skin porosity, which the author observed in tests on tough-pitch arsenical copper billets cast under normal conditions.

Another outstanding paper, by Mr. W. Singleton and Mr. Brindley Jones, dealt with the effect of the addition of tellurium to lead, the results recorded being of special significance when considering the practical applications of lead, especially in the form of pipes. Here one of the essential features is pliability, with the added capacity of yielding to the stresses which are liable to be encountered in service. In addition the ability to yield must be combined with toughness in order to avoid local weakening and consequent fracture. From the tensile tests which the authors placed on record it is evident that tellurium-lead, when strained, behaves in a manner previously unknown in lead and lead alloys. Pipes made of ordinary lead and lead containing 0.05 per cent. tellurium, $\frac{3}{4}$ inch internal diameter and $\frac{1}{8}$ inch wall thickness, were filled with water, suitably plugged and repeatedly frozen under identical conditions until bursting occurred. In this test all the pipes made from ordinary lead showed marked local distension after the first freezing, and fractured during the next freezing with the formation of large bulge. The pipes made of tellurium-lead, on the other hand, were quite symmetrical after three freezings. Only after the fourth freezing was a slight distension noticed; at the fifth freezing failure occurred with a local bulge of moderate size. Rapid hydraulic bursting tests, which were subsequently carried out on pipes of the same dimensions, indicated a bursting pressure of 725 lb. per sq. inch in the case of ordinary lead and 800 lb. per sq. inch for tellurium-lead. Another sample of the same batch of tellurium-lead pipe was subjected to three freezings. When hydraulically tested after 24 hours the pipe resisted an hydraulic pressure of 750 lb. per sq. inch before bursting. Even after three freezings, with the consequent reduction in wall thickness due to expansion, the resistance of the tellurium-lead pipe to hydraulic bursting was still maintained. Under similar conditions a lead pipe burst after two freezings. This experiment reveals what may be described as latent strength—a property not indicated by the results of ordinary tests where strain is rapidly applied.

The addition of tellurium to lead raises the temperature of recrystallisation; tellurium-lead can therefore be permanently work-hardened for use at ordinary temperatures. The prevention of self-annealing after cold working appears to be complete at about 0.05 to 0.06 per cent. tellurium. By extrusion, tellurium-lead can be produced in a soft condition, having a very refined grain, and this extruded material, owing to the manner in which it responds to stress, will undergo an unusual degree of distortion before it fractures. These are the chief conclusions summarised by the authors, whose further investigations have shown that the effects produced by the addition of tellurium to lead are to some extent also produced by tellurium when added to binary lead-tin and lead-antimony alloys, and to the ternary alloys in which cadmium is also present.

Steel Industry Re-organisation

AN early statement is expected from the Import Duties Advisory Committee with reference to the report of the National Reorganisation Committee of the iron and steel industry. Appointed June 1932, the iron and steel committee has now submitted its final report, but the report itself has not yet been issued. It is understood that the proposals put forward include the concentration of iron and steel production upon those units which are most suitably situated, geographically or industrially, for the manufacture of certain products, and that special steps have been taken to safeguard consumers. In the absence of authoritative information, however, it is possible that detailed forecasts of the contents of the report have been based on an early draft which has been modified in several respects. According to Sir William Larke, director of the National Federation of Iron and Steel Manufacturers, and secretary of the committee, pending consideration by the Import Duties Committee details of the scheme submitted by Mr. Mitchell's committee are still confidential. Among the plans forecast was one for the establishment of a £200,000,000 iron and steel "trust" with a permanent full-time chairman, which would " rationalise " the whole of the industry from pig-iron to finished products. Four regional committees and ten area producers' associations were mentioned as forming the framework of the scheme, together with a levy designed to finance the central corporation of all iron and steel produced in this country.

Steel Merger in the North-East

IT is officially announced that a provisional agreement has been reached between the directors of Dorman, Long and Co., Ltd., and the South Durham Steel and Iron Co., Ltd., for an amalgamation of interests. The scheme of amalgamation will require the consent of the debenture holders and shareholders of the two companies. No reference is made in the official statement to the terms of the proposed amalgamation, but it is understood that they will involve a drastic reconstruction of the capital of Dorman, Long and Co. Unofficially, it is stated that the chairman of the new concern will be Mr. Charles Mitchell, the present chairman of Dorman, Long and Co. Lord Furness, chairman of the South Durham Steel and Iron Co., it is believed, will not be a member of the board of directors, but Mr. Benjamin Talbot, the managing director and deputy chairman, will take an active part in the management of the new concern, which will most probably carry on business under the name of Dorman, Long and Co., Ltd., whose world-wide reputation has made the name an exceedingly valuable trading asset.

The object of unification of control is to enable an impartial selection to be made of those units of production which can be most economically remodelled and which will yield the best results of such a process of development. At all stages of production substantial economies can be effected. Coke ovens, blast furnaces, smelting furnaces, and rolling mills all offer opportunities for reducing production costs. Mere size, however, offers no attraction to the iron and steel manufacturers, but size plus operation at high capacity offers a sound possibility of economic production.

Effect of Concentration

QUITE apart from the need for radical re-modelling of plant, substantial economies can also be effected by concentrating the tonnage of work available at a few units instead of dissipating it over a large number. In this way greater outputs will be possible at selected units, and it has been proved that striking reductions in costs can be obtained merely by keeping the rolling mills operating on a good load. It will be seen, therefore, that the first step in such a policy is the bringing together, under single control, of the chief groups on Teeside. Having accomplished this, the considered development of resources and organised planning for extension can be undertaken concurrently with the elimination of those plants which have served a useful life, and the cost of whose re-modelling would be excessive. For some years Dorman, Long and Co. have had plans prepared for the erection of a central battery of coke ovens at an estimated cost of about £1,000,000. The scheme has been held up indefinitely although it is known that such an undertaking would yield a handsome return, and increase economy of operation throughout the whole series of processes in steel manufacture. It is probable, therefore, that the erection of a central battery of coke ovens designed to serve the whole group would be one of the first developments undertaken in the re-modelling of the industry on Teeside. Another urgent matter is the modernising of the blast-furnace equipment.

Creep, Weld Decay and Erosion

CREEP, weld decay, and erosion in metals have recently been subjected to a series of special studies by the Westinghouse Research Laboratories, at East Pittsburgh, Pa. They are are all factors which are not directly dependent on the resistance of a given metal surface to different chemical reagents. Following the proper choice of material, however, they stand next in importance in the choice of enduring equipment. For the study of welds, an accelerated corrosion device has been constructed which subjects specimens to intermittent immersion in a corroding liquid. The samples are submerged for a definite period, leaving them at rest; then they are removed and exposed to the air for a definite period. They are in motion only for a very small fraction of the cycle. The apparatus, whose timing can be regulated, is equipped to keep the reagents at constant temperature and the samples are suspended from the rack by glass hooks, horsehair, or silk. Accelerated creep tests according to " Chemical and Metallurgical Engineering," have not been as satisfactory, but they have at least emphasised the numerous precautions and possible errors in dealing with the subject. Since creep requirements are often restricted to as small a value as 0.001 per cent. per year, even with very accurate measurements the length of a creep test gives no indications of the long conditions of service. Experimental creep rate is not a satisfactory basis for design. For the purpose of studying alloys subjected to rapid erosion, small cut slugs intercept two minute jets of water as they whirl against them at a speed of 20,000 r.p.m. In comparable tests, different compositions of resistant iron and steels were cut in half in 2 to 4 minutes; these slugs received 667 impacts per second.

Recent Advances in Silumin Castings

Development Work by the Metallgesellschaft A.G.

THE aluminium foundry alloy silumin, which was first introduced into Germany and most of the other countries of Europe by the Metallgesellschaft, has had no easy task in maintaining and extending the position it originally won through its many excellent properties and the energy with which the firm concern explored the possible fields of application. As this alloy of aluminium and silicon is prepared electrolytically from the purest raw materials, it is, as a matter of course, much more expensive than the numerous scrap alloys on the market. In comparison with the magnesium alloy electron, it is at a disadvantage on account of its higher specific gravity. It has, further, to compete with grey iron, the properties of which have been considerably improved in recent years, and finally, it has a formidable rival in welded steel plate.

According to Professor G. Sachs, head of the Metallurgical Laboratory of the Metallgesellschaft A.G., of Frankfort-on-Main ("Metallgesellschaft Periodic Review," March, 1933) the development of new special alloys on a silumin basis has opened up wide fields of application wherever castings of intricate form are required which are subjected to high demands in respect to mechanical strength and chemical resistance. Improved methods of melting, moulding and founding have brought silumin castings to such a high standard of quality and homogeneity that, when casting is carried out by experienced hands, this foundry alloy now guarantees almost the same degree of reliability as rolled material. The original silumin owed its wide use and manifold applications above all to its excellent casting qualities, which enable it to be poured into moulds of the most complicated pattern with the thinnest of walls, and ensure a high degree of uniformity and good mechanical properties. For sand castings, which comprise the great majority of the total output of silumin castings, the alloy has now, of course, to be refined or "modified" by the addition of sodium or a sodium salt in order to attain the high mechanical properties desired. In unmodified sand castings tensile strength and elongation are low, since the brittle silicon crystals, which appear in the form of hexagonal plates, break up the coherence of the tough aluminium matrix. The effect of adding the sodium is that the silicon crystals are greatly reduced in size, and are, moreover, rounded in outline, so that they now, as hard inclusions, merely increase the hardness of the aluminium crystals, without impairing the ductility of the alloy.

Improvement of Surface Appearance

In the course of time, however, it has been found that silumin treated in this way sometimes shows unsightly surface appearance. When melting and casting conditions are unfavourable, modified silumin has a tendency to develop fine pinholes. In consequence of their spherical form these discontinuities have but little effect on the mechanical properties of the silumin, and the loss of section and diminution of tensile strength are as a rule both small while castings with these pinholes are also impervious to penetration by water or air. In this respect, indeed, silumin has a great advantage over all other light metal alloys, in which the discontinuities appear in branched or spongy forms, and consequently disintegrate the coherence of the structure far more than the round pinholes. On the other hand, the latter are much more plainly visible to the naked eye, and, moreover, their appearance is particularly unwelcome wherever, for technical reasons connected with machining or later application, a perfectly smooth machined surface is specially desired. By dint of intense research work, however, a means has now been found of eliminating pinholing in silumin to a large extent. To attain this end, it has been found that it is necessary to supplement the treatment with metallic sodium (which had hitherto been preferred for reasons of economy) by a treatment with salts.

The high demands made by present-day engineering for materials of first class quality have led to an intense study of casting technique, with the result that there has been a general all round improvement, and silumin has also shared the benefits of all such improvements. For mass production the most suitable form of casting is chill casting. Here, again, silumin has a most decided advantage over other alloys, *viz.*, in the fact that it has no appreciable freezing range of temperature, but crystallises as a eutectic alloy at a constant temperature. Consequently, it does not, like most other alloys during the solidifying process, go through the mechanically extremely weak pasty stage, in which cracks are liable to develop, especially in consequence of the cooling shrinkage, in which the capacity for filling out all parts of the mould is very much reduced. Silumin, on the contrary, is, at any particular part of the mass, either quite solid or completely liquid, and therefore has no tendency to cracking, can be cast into intricate shapes, and admits of the most rapid cooling. Consequently, even large and difficult parts can with advantage be produced in the form of silumin chill castings. In contrast to a sand casting, the rapid cooling of a chill casting produces a finer crystalline structure, and better mechanical properties. For this reason also very satisfactory results have been attained in silumin sand casting by the extensive use of iron chills, which are inserted in the sand mould, especially in the thicker sections. Silumin is also extensively used for die-casting. Its excellent casting qualities are here especially evident when very intricate designs have to be dealt with; the exceedingly rapid cooling further improves the mechanical properties. In making silumin die-castings, however, it is of advantage to use machines with which there is little absorption of iron, although the deleterious effect of iron on silumin may be avoided to a certain extent by the addition of manganese.

Good Casting Qualities

The normal silumin casting, practically consisting solely of aluminium with 13 per cent. silicon, is distinguished by its high resistance to corrosion, its high elongation and good tensile strength. Its high elongation allows castings which are liable to warping through the uneven cooling of sections of varying thicknesses to be easily straightened up in assembling. These properties, together with its good casting qualities, make silumin the most appropriate material for many structural purposes, and for chemical plant.

Though the original silumin had been converted by the exceedingly peculiar sodium modification from a metallic mixture of very restricted utility to a valuable structural alloy, still even this "modified" silumin was unable to satisfy the ever higher demands of the engineering world. Some engineering works, for example, found that for certain purposes a higher fatigue strength was urgently needed. As the Metallgesellschaft stands in close correspondence with users of silumin, keeping up a regular mutual exchange of experiences, supplying the works in question with constant advice and giving them immediate information concerning all the newest improvements and discoveries in connection with silumin, a series of exhaustive experiments was at once started with a view to the desired improvement of the alloy. The united work of the Metallgesellschaft and a few leading works that were equipped with efficient laboratories soon achieved the improvement aimed at. By adding only 0.8 per cent. of copper the fatigue strength was materially increased, and so copper-silumin was then introduced for highly stressed structural castings. Through this improvement silumin was enabled to hold its own in certain important fields of application and also to open up many new fields. In the construction of aircraft motors, for example, copper-silumin is now the most widely used material. The newest developments in the construction of the Diesel engine are also closely connected with the use of copper silumin, which has hitherto proved fully equal to the specially high demands made by this type of engine. Later, a small percentage of manganese (about 0.3 per cent.) was added to copper-silumin, as this slightly increases the hardness of the alloy, and proves especially useful when the iron content (or the copper content) is raised through lack of care either in adding the metal or in casting.

The growing demands for better mechanical properties and for greater safety, especially in aircraft construction, have

for some time past given rise to the development of heat-treated aluminium alloys. The essential constituent in such alloys is generally copper within a range of from 1 to 5 per cent. These alloys, however, have taken a long time to establish themselves in practice, as they require the most meticulously careful casting on account of their strong propensity to yield unsound castings. Heat-treated alloys have hardly come into use at all as yet in Germany, while in foreign countries their introduction has been more notably advanced through the interest shown by the Governments in the aircraft industry on military grounds. Silumin being thus particularly distinguished by its excellent casting properties, it was but natural that a heat-treated alloy on the basis of silumin should be developed. The first beginnings of this development lie a long way back. It was already known that the addition of magnesium renders it possible to give silumin much greater strength and hardness by quenching from high temperatures and then tempering.

Quite recently it has been found that heat-treated silumin is also marked by high fatigue strength and practically complete indifference to the abrupt changes of temperature involved in the heat-treatment. A new special silumin was therefore put on the market last year under the name of silumin-gamma, containing 12 per cent. silicon and varying amounts of magnesium up to 0.5 per cent., according to the degree of hardness required, and also from 0.3 to 0.5 per cent. manganese. Already in the untreated form (silumin-beta) the new type of alloy is almost equal in value to copper-silumin, in regard to static strength, and it is superior to it in dynamic strength. Hardness and yield point can be considerably increased simply by tempering (silumin-gamma, tempered). When the full heat-treatment is carried out (silumin-gamma, age-hardened), the most important mechanical properties are still further enhanced, hardness and yield point being about 100 per cent. higher, tensile strength and fatigue strength about 50 per cent. higher. This alloy is also superior to copper silumin in possessing a higher corrosion-resistance, since copper always helps corrosion in aluminium, while magnesium and manganese have very little influence on it.

Dilational Properties of Nickel Iron Alloys

Some Applications in the Electrical Industry

NICKEL iron alloys have properties peculiarly useful for certain purposes in the electrical industry, said Mr. C. J. Smithells, of the Research Laboratories of the General Electric Co., Ltd., in the course of a paper read before the Birmingham Section of the Institute of Metals, on March 16. Coefficient of expansion is one property of special importance. Invar contains 36 per cent. of nickel, together with about 0.1 per cent. carbon and 0.5 per cent. manganese, whilst sulphur, phosphorus and other elements are rigorously excluded as they tend to increase the expansion. This alloy is made either in the open hearth, crucible or electric furnace. From its melting point (1,425° C.) down to 200° it is a homogeneous solid solution and in this range of temperature its expansion is just about the same as that of ordinary Bessemer steel. Below 200° it undergoes a reversible transformation, and between 0° and 40° C. the coefficient of expansion is only 1 to 2 millioneths per °C. If the proportion of efficient of expansion becomes larger. A small variation in nickel content has less effect on the alloys containing more than 35 per cent. nickel than with those containing less. This is an important point because if a particular coefficient is desired it is better to choose an alloy on the high nickel side, which will be less affected by accidental variations in compositon. These alloys have been used as substitutes for platinum for sealing into glass.

Substitutes for Platinum

In the manufacture of electric lamps it is necessary to carry the current to the filament by means of wires passing through the glass bulb, and these must be sealed into the glass so as to maintain a vacuum tight joint. This can only be obtained if the coefficients of expansion of the glass and the wire are closely the same; it is also essential that the glass should wet the wire. Platinum was used in all the early lamps, as its properties are peculiarly suitable. It does not oxidise in the flame, it wets glass, and its coefficients of expansion (9×10^{-6}) is very close to that of the common glasses (about 7.6 to 9 $\times 10^{-6}$). Its cost, however, made it desirable to find a cheaper substitute, but none of the common metals have a low enough coefficient. In 1881 Sir William Crookes was successful in producing a composite wire of high conductivity consisting of a core of copper or silver over which was drawn a sheath of platinum; the whole was then reduced by wire drawing. The next important advance was made by Guillaume, who suggested the use of nickel-iron of suitable composition to give the desired coefficient of expansion. Unfortunately glass does not wet these alloys, but by coating the wire with platinum a satisfactory composite wire was produced.

About 10 years ago a still cheaper substitute was introduced and is now used universally. This consists of a core of nickel-iron having a lower coefficient of expansion than that of the glass, coated with copper, so that the combined expansion matched that of the glass. A nickel-iron rod containing 42 per cent. nickel, three feet long and about 5/16 in. diameter is coated by electro-deposition, with 28-30 per cent. by weight of copper and then drawn down into wire. The process of depositing the copper has to be carried out very carefully to avoid any holes between the core and the copper, and to ensure their perfect adhesion during drawing. The various steps in the process are: (1) Nickel-iron annealed in hydrogen gas; (2) cleaned in caustic; (3) etched in 50 per cent. nitric acid; (4) short plated in cyanide; (5) main plated in sulphate; (6) annealed; (7) drawn to 0.3 mm.; and (8) finally coated with potassium borate which is baked on to form a layer of copper borate. This layer of copper borate protects the wire from oxidation and helps the glass to wet the copper.

Large Glass-to-Metal Joints

The possibility of getting a satisfactory joint between glass and metal has made possible the large water cooled valves dissipating 100 or even 500 kW. In this case nickel-iron alloy with expansion equal to that of glass is used since conductivity is not important. A shallow cone is pressed out of sheet, the thickness of which is chosen according to size of joint. The bottom is turned out of the cone, which is then fairly heavily copper plated and silver soldered on to the copper anode. Copper plating is not put on for any reason connected with the expansion of the metal but because it makes the silver soldering easier. The nickel-iron then turned so that it tapers to a knife edge and most of the copper is removed during this operation. The nickel-iron is finally given a thin copper plate, which is subsequently borated. The actual operation of joining the glass on to this nickel-iron ring is carried out on special glass lathes which have been developed for the purpose. Instead of using nickel-iron, copper alone can satisfactorily be joined to glass if the edge is made sufficiently thin. The strength of such a joint relies on the ductility of the copper and not upon having equal coefficients of expansion. As the joint is heated or cooled the copper is actually deformed and follows the changes in dimensions of the glass which readily wets the copper to which it adheres very firmly.

A further example of the application of the dilatational properties of nickel iron alloys is provided by bimetallic strip. For this purpose two metals or alloys of widely different expansion are joined together by welding, followed by rolling or by electro-deposition. It is usual to use a nickel-iron alloy of a composition not far from that of Invar for one side, with brass, copper or some other metal with a high or normal expansion on the other side of the strip. Such a strip, when heated, bends and use is made of this movement in automatic temperature control devices.

The Iron and Steel Institute

Arrangements for the Annual Meeting

THE annual meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers, Gt. George Street, Westminster, on May 4 and 5, commencing each day at 10 a.m.

The programme of proceedings on Thursday, May 4, includes the induction of newly-elected president, Mr. W. R. Lysaght; the presentation of the Bessemer Gold Medal to Dr. W. H. Hatfield; and the presidential address. Papers presented for discussion will include "Coke Consumption in Blast-Furnace Practice: Effect of Removal of Breeze," by D. F. Marshall and R. V. Wheeler; "The External Heat Loss of a Blast-Furnace" by D. F. Marshall; "Recent Developments in American Blast-Furnace Design and Practice" by W. A. Haven; "Structural Changes in Hypo-Eutectoid Steels on Heating" by Sir H. C. H. Carpenter and J. M. Robertson; "Some Comparative Corrosion-Fatigue Tests Employing Two Types of Stressing Action" by H. J. Gough and D. G. Sopwith"; and "Formation of Columnar Crystals in Steel Sheets after Normalisation" by F. Kinsky. The annual dinner of the Institute will be held at Connaught Rooms, Great Queen Street, W.C., at 7.30 p.m.

On Friday, May 5, announcement will be made of the award of the Andrew Carnegie Research Scholarships for 1933-34, and of the award of the Williams Prize to Messrs. A. B. Winterbottom and J. P. Reed, Birmingham, and Mr. J. R. Handforth, Acton. Papers presented for discussion will include "Contribution to the Study of Inclusions in Steels" by A. M. Portevin and R. Perrin; "The Influence of Phosphorus on the Properties of Hardened and Tempered Cast Iron" by J. E. Hurst; "The Effect of Sulphur and Phosphorus on the Corrosion of Iron" by L. Tronstad and J. Sejersted; "Internal Combustion Engine Exhaust Valve Failures" by C. C. Hodgson; "A Contribution to the Study of the Properties of Austenitic Steels" by L. B. Pfeil and D. G. Jones; "The Intergranular Corrosion of the 18/8 Stainless Steels" by E. C. Rollason; and the "First Report of the Steel Castings Research Committee."

Autumn Meeting

The autumn meeting of the Institute will be held at Sheffield, September 12-15, the last day being devoted to a whole day's visit to Scunthorpe, to visit the iron and steel works in that district (John Lysaght, Ltd., and Frodingham Iron and Steel and Appleby Iron Companies, Ltd.). This meeting will be held under the presidency of Mr. W. R. Lysaght. A general reception committee is in process of formation, of which the Lord Mayor of Sheffield, Alderman Ernest Wilson, J.P., has consented to become president, and Colonel A. N. Lee, the Master Cutler of Sheffield, Dr. A. W. Pickard-Cambridge, vice-chancellor of the University, and many other prominent citizens, including all the leading industrialists of the district, have accepted the invitation to join.

An executive committee, consisting of Professor J. H. Andrew (hon. secretary), Mr. H. Brearley, Mr. W. J. Brooke, Mr. F. Clements (hon. treasurer), Mr. W. J. Dawson, Mr. J. H. S. Dickenson, Mr. J. H. Doncaster, Dr. W. H. Hatfield (chairman), Mr. J. Henderson and Mr. E. H. Saniter was formed some time ago to carry out the necessary arrangements for this meeting.

The Institute of Metals

New Officers for 1933-34

AT the recent 25th annual general meeting of the Institute of Metals, held in London, the following officers were declared to be elected for the year 1933-34:—President, Sir Henry Fowler, D.Sc.; vice-presidents: C. H. Desch, D.Sc., F.R.S., Professor R. S. Hutton, D.Sc.; Members of Council: Engineer Vice-Admiral Sir Robert Dixon, Wesley Lambert, H. C. Lancaster, A. H. Mundey, A. J. G. Smout, and F. Tomlinson.

The silver jubilee meeting of the Institute will be held in Birmingham, September 18-21. It was in Birmingham that the first general meeting of the Institute was held in the autumn of 1908, under the presidency of the late Sir William H. White, F.R.S.

Nickel Chromium Austenitic Steels

Corrosion Investigations

RESEARCH carried out in the laboratories of Harvard University, comprising a study of the resistance of straight and complex nickel-chromium austenitic steels to sulphuric acid, and an investigation of the phenomenon of weld decay (intercrystalline corrosion), is described in the "Carnegie Scholarship Memoirs" of the Iron and Steel Institute, 1932, *21*, 111. Part I includes a study of the effect of additions of various elements on the resistance of iron to sulphuric acid, 125 alloys being examined, the large majority containing high percentages of nickel, with chromium and/or molybdenum, silicon and copper. There are also notes on the development of a comparatively inexpensive acid-resisting alloy, and the determination of the resistance of commercial alloys to sulphuric acid. In general, it is concluded that alloys containing copper, silicon, molybdenum and nickel show the best resistance, complex steels being more resistant than those containing fewer elements. The effect of the individual elements is separately assessed. As a result of combined considerations of corrosion resistance, physical properties and cost, two compositions are believed to show special promise: (a) nickel 30, copper 3, silicon 3 per cent, and (b) nickel 30, copper 10, silicon 3 per cent. Part II is devoted to a review of the literature of intercrystalline corrosion and experiments are reported on alloys of varying nickel and chromium content, special attention being devoted to a study of the 18/8 type. Here conclusions are drawn in relation to the maximum amount of carbon which can be retained in solid chromium after heating within the carbide precipitation range, and in regard to variable affecting rate of precipitation, and form and size of precipitate. The relation between susceptibility to corrosion and the of iron present is found to be only limited validity, depending on the time of heating with the precipitation range. Suggestions are made for a method of heat treatment for the elimination of intercrystalline corrosion, and a new theory of carbide precipitation is proposed.

Indian Mineral Production

A General Decline Recorded

THE value of the mineral production of India has been steadily declining since 1924 and from £28,000,000 in that year it came down to £19,000,000 in 1931. Coal production during the year declined by over 2,000,000 tons, or about 9 per cent. The output of iron decreased by about 12 per cent. and amounted to 1,624,000 tons. The total production of pig iron fell from 1,175,000 tons to 1,058,000 tons. The manufacture of steel by the Tata Iron and Steel Co. showed satisfactory increase, as also the production of ferro-manganese, the latter increasing from 4,500 tons to 14,000 tons. The output of other companies and of the Mysore Iron Works showed a decline. Output of copper ore increased to 153,000 tons, valued at £165,000. Operations at the works of the Indian Copper Corporation, Ltd., show a production of refined copper amounting to 4,069 tons of which 2,462 tons were consumed in the rolling mills. There was considerable decrease in the production of copper matte at the Namtu smelting plant of the Burma Corporation, Ltd. There was a regular production of nickel-speiss of about 3,000 tons as a by-product in smelting operations of the Burma Corporation. There was a slight decrease in tin production, the amount mined during the year being 4,255 tons; the output of tungsten was 2,247 tons, a slight decline; zinc concentrate declined from 57,000 to 51,000 tons.

Rust Prevention in Idle Steam Boilers

METHODS recommended for the prevention of rust in steam boilers when temporarily out of use include drying out with a slow charcoal fire and treatment with calcium chloride. Greater satisfaction is now said to follow when the air-dry boiler is simply filled with ammonia gas. According to Dr. E. Seyb ("Archiv Wärmewirtschaft," 1933, page 16), the danger of explosion is extremely remote and the boiler is again ready for use after twice washing out with pure water.

Some Recent Metallurgical Patents

Bright Annealing

IN the bright annealing of brass or other alloys containing zinc or cadmium, according to Specification No. 383,762, of the Electric Resistance Furnace Co., Ltd., and A. G. E. Robiette, stains are removed from the surface of the alloy by passing an inert gas forming the annealing atmosphere over turnings or small particles of the same composition as the alloy and heated to the temperature of the furnace, the oxygen of any occluded gases or air present in the furnace being taken up by magnesium powder or other suitable oxidisable agent such as chromium, manganese, aluminium, calcium, sodium or potassium or alloys containing above 10 per cent. of these metals. The inert gas may be passed over zinc or cadmium contained in a heated vessel outside the furnace.

Corrosion-Resisting Iron Alloys

CORROSION resisting iron alloys containing 0.2 to 0.5 per cent. of copper, and 0.01 to 0.5 per cent. of tungsten, with or without up to 0.5 per cent. of chromium, the total amount of carbon, manganese, silicon, phosphorus, and sulphur being not more than 0.3 per cent., are described in Specification No. 383,500, of the Soc. Anon. des Hauts-Fourneaux Forges et Acieries de Pompey, of Paris. The carbon may be less than 0.05 per cent., the manganese less than 0.25 per cent., and the silicon, phosphorus, and sulphur each less than 0.02 per cent. In making the alloy, the melt may be protected by a silicon-lime slag, the copper being introduced at the beginning of the deoxidising operation, and the tungsten and chromium at the end.

Bronzing Surface Treatment

IN bronzing iron, steel, or their alloys, according to Specification No. 383,567, of B. Guerini, the metal is treated to remove grease, subjected to one or two pickling treatments, immersed in an alkaline solution containing lead dioxide, a nitrated derivative of toluene or phenol, and nitric acid, with or without ammonia, and finally immersed in hot vegetable oil to remove traces of alkali. The metals are preferably degreased in a bath of boiling 10 to 20 per cent. caustic soda and then washed. They are then pickled in a bath of 5 to 10 per cent. sulphuric, hydrochloric, or hydrofluoric acid. Articles made of iron or ordinary carbon steels are then washed and transferred to the bronzing bath, but articles of cast iron or of alloy steels are subjected to a second pickling in a bath of 10 per cent. hydrofluoric acid contained in a basin of paraffined wood. The bronzing bath may comprise 60 parts of caustic soda, caustic potash or ammoniacal caustic soda, 2 parts of trinitrotoluene or trinitrophenol, 0.8 part of lead dioxide, and 2.95 parts of nitric acid. For immersion in the bronzing bath the articles are placed in small boxes of thin sheet iron, with double walls and double ends, thermally and electricaly insulated, and with perforated covers.

Moulding from Powdered Metals

LARGE crystallised bodies, such as blocks, bars, sheets, bands, wires and single and multiple spiralled incandescent bodies, of refractory metals such as tungsten, rhenium, and molybdenum can be produced by incorporating additive materials with the starting materials, and heating first to the sintering temperature and then to the crystallisation temperature, the additive materials being such as will not volatilise at this latter temperature but develop a vapour pressure in the metal bodies, setting up internal stresses. According to Specification No. 384,309 of Vereinigte Gluhlampen und Electricitäts Akt.-Ges. the crystallisation temperature is of the order of 1,000 to 1,200° C. above the sintering temperature, which for tungsten is about 1,500° C. Additive materials include iron, aluminium, thorium, magnesium and zirconium silicates, etc. in quantities varying from 0.01 to 0.30 per cent. are specified. The additive materials or their components may be admixed with the reduced metal powder or with the raw materials, *e.g.*, tungstic acid, from which the metal is produced. In an example, a thin paste of tungstic acid hydrate is admixed with solutions of sodium or ammonium fluoride and barium chloride. The paste is dried at 300° C. and reduced in hydrogen at 820° C. The metallic powder is moulded and heated in hydrogen at 1,100° C., and then in hydrogen by a high-amperage low-voltage alternating current to a temperature above the sintering temperature.

Magnetic Alloys

MAGNETIC compositions containing two or all of the metals, iron, nickel, and cobalt, with or without other elements, for example, molybdenum, vanadium, chromium, manganese, titanium, silicon, and aluminium, are described in Specification No. 383,691, of J. Y. Johnson (I. G. Farbenindustrie). These alloys are made by consolidating and inter diffusing mixtures of finely divided metal powders under such conditions of temperature and pressure that while alloying takes place to a certain extent the product does not become homogeneous. The heating, which may be at 600 to 1,000° C., is preferably carried out in an inert or reducing atmosphere or in a vacuum; the time of treatment varies with the size of the particles and with the nature of the mechanical treatment.

Selenium in Alloy Steels

Improving the Working Qualities

IN the recent past, sulphur has been the principal additive to ease the difficult working qualities of chrome-nickel steels, but there are various difficulties that accompanied its use which have favoured the recent debut of selenium in ferrous metallurgy. After experimental work had been completed by the Carpenter Steel Co., in the United States, they found that in practice ferro-selenium had to be added to the molten steel. Shortly before the pour, a specified quantity is added on the surface of the metal and quickly compounds with the steel. The casting, hammering, rolling and annealing proceed just as in any other chrome-nickel alloy and its final composition is 18 per cent. chromium, 9 per cent. nickel and 0.25 per cent. selenium. Its advantage is that it can be drilled, tapped, threaded and otherwise machined with ordinary shop tools and practice.

Selenium is said to have several distinct advantages over sulphur as a free-cutting agent. The latter, when added to a steel bath, combined to form sulphides which are entirely insoluble in steel and occur in the castings as small non-metallic particles. In the hot working of the steel, these are drawn out into long threads which interrupt the continuity of the metal and render it less ductile in a transverse direction. Selenium also forms metallic selenides, but as these are partially soluble, there is less stringer formation and the finished product is much tougher and less subject to transverse fracture. Experiment indicates that the free-machining qualities are proportional to the total selenium content. Tensile and impact tests made transverse to the direction of rolling on free-machining alloy steel show that selenium yields about one-third greater elongation and reduction of area and twice the impact resistance of sulphur. The ultimate strength is the same for both types. Selenium also increases the passivity to specific reagents, such as boiling solutions of acetic acid and aluminium sulphate.

Hygienic Aspects of Aluminium

Mellon Institute Bibliography

A SELECTED and annotated bibliography on the hygienic aspects of aluminium and aluminium utensils has been published by Mellon Institute of Industrial Research, at Pittsburg. Since 1926 the Institute has been investigating the metals used in the construction of cooking utensils, industrial food-preparation equipment, and of food and beverage containers, with special reference to the physiological action of aluminium and its alloys and to the effects on foods and food constituents. Many inquiries have been received about the hygienic aspects of aluminium utensils during the progress of this work, and the Institute therefore decided to make the findings of their critical studies of the literature available in the form of a bulletin, which might serve as a guide to those who wish to follow in detail the chemical and medical investigations that have stamped aluminium as one of the suitable metals for the construction of equipment for the handling of food. The introduction to this bulletin has been written by Dr. George D. Beal, assistant director of Mellon Institute, who has been in supervisory charge of these studies.

Metallurgical Section

May 6, 1933

The Iron and Steel Re-organisation Scheme

THE National Committee of the Iron and Steel Industry, constituted last summer to prepare a scheme for the re-organisation of the iron and steel industry of this country, has completed the preliminary stage of its task. In the scheme put forward the National Committee recommends that a corporation should be set up to supervise and control the more specialised work of some dozen separate associations each of which represents a particular group of iron and steel products. The object of this Iron and Steel Corporation of Great Britain, as the National Committee proposes to designate it, will be to promote amalgamations, re-equipments and the scrapping of plant which appear to be necessary in the interests of the industry. Whilst there should be no insurmountable difficulty in working out the details of what is to be done, it is to be anticipated that the new organisation may find some difficulties in carrying the scheme into operation, as it will not be armed with any powers for interference with individual members and will therefore lack means to enforce its recommendations. There is a suggestion, however, that the threat of Governmental pressure will be at the disposal of the corporation and under such circumstances the individual member of the industry may hesitate to refuse acceptance of the scheme.

It will be recalled that the National Committee of the Iron and Steel Industry was formed at the request of the Tariff Advisory Committee which insisted that if the industry was to be afforded protection by tariffs over a period of years it must undertake a radical re-organisation. The scheme which has been evolved provided that the suggested corporation shall embrace the whole of the iron and steel producing concerns in Great Britain, together with the principal ancillary trades such as re-rolling, and the manufacture of tinplates, forgings, etc. By replacing the many existing associations within the iron and steel industry—including the National Federation of Iron and Steel Manufacturers—by a much smaller group, it should certainly be able to bring about the possible co-operation between the manufacturers and the principal users of iron and steel products. Explained in greater detail, the functions of the new Iron and Steel Corporation of Great Britain will include services of an advisory character for the assistance of its members and associations, *e.g.*, statistics, trade intelligence as to home and foreign markets and transport facilities. It will also promote the formation of approved associations and exercise such supervision over them as is necessary to secure the orderly progress of the industry, whilst by agreement with approved associations it will provide or assist in the provision of services of general benefit to members, such as, central purchasing, marketing and research. Another duty will be to assist approved associations in any measures calculated to promote the efficient organisation of their respective sections of the industry, including (1) the promotion of desirable amalgamations of existing undertakings and extensions and improvements of plant as and when required; (2) the prevention of unnecessary duplication of plant, whether by existing members of the association or by other producers. Finally it will co-operate with approved associations in promoting the export trade in iron and steel, and act on behalf of the industry generally in all negotiations with outside interests.

In the words of the National Committee's memorandum, the scheme now submitted may perhaps be more correctly described as "a scheme for establishing the machinery whereby a re-organisation of the industry may be carried out, rather than as a scheme of re-organisation itself, and its ultimate success will entirely depend upon the vigour and single-mindedness with which that machinery is used." To this end the scheme has been purposely drawn on broad lines, and with an elastic structure so that it will be readily adaptable to the present changing conditions of trade and industry. In the first place it aims at setting up an organisation in this country which will have the power to negotiate arrangements with producers abroad, whilst being in a position to apply the necessary degree of control at home for the dual benefit of the industry and the nation generally. Mere regulation of production, it is pointed out, will not alone suffice to place the industry in a position to play its proper part in the national economy.

While leaving full scope for consolidation, the scheme seeks to provide a solution by co-operative action under which the interests of the industry are safeguarded to the maximum possible extent, while it is evolving an organisation adequate to present-day needs. For this purpose it is proposed to adapt and improve on the existing machinery of trade associations and the National Federation of Iron and Steel Manufacturers, grouping the associations, which are at present mainly price maintenance bodies, into a smaller number for the control of production in the several main divisions of the industry, and giving a new central organisation the power, which the Federation now lacks, to support and co-ordinate the activities of the associations. Whether or not statutory powers will be necessary to make the scheme effective depends upon its ultimate acceptance by the industry. Assuming that all the substantial producers of pig iron and ingot steel, and a good majority of the manufacturers of secondary products, join the proposed corporation when it is constituted, "pressure

upon any opposing section " might be exerted by suitable rebate schemes. These might " provide, on the one hand for preferential prices for supplies to members of the corporation, and on the other hand, bind purchasers by means of special rebates to take only products of the corporation."

Steel Castings Research

THE first report of the Steel Castings Research Committee has now been published by the Iron and Steel Institute. Dealing with the manner in which characteristic defects in castings, designed to withstand severe conditions of service, were affected by experimental variation in the method of manufacture, this report draws some interesting conclusions. It is pointed out that the spacing of the heads, as well as their size and shape in relation to the adjacent portion of the casting, exercises a considerable influence on the efficiency of feeding the molten metal. Sections of typical heads indicated that the narrow heads solidified in such a way as to give long discontinuous piping, while shorter heads of greater cross-section and weight were more efficient and gave an extensive cavity near the top passing into a narrow pipe in the lower part. In castings in which the heads were unevenly placed, evidence of the direction of flow of metal was also apparent in the macrostructure. When the runner led into a thick section in the middle of a casting, its heating effect delayed solidification which proceeded from the ends, and the central section was thereby subjected to stresses while still in a weak condition. This was avoided when the metal was run into the narrower walls and the thicker sections were fed by heads, although there are serious objections to running the metal direct into a narrow wall. The rate of filling the mould was also found to be important, for if castings are arranged in order of the time taken to fill the mould, other variables being neglected, they bear a close relation to the freedom from cracks. With a favourable position in the mould and a proper distribution of heads, variations in the casting temperature (1,557° to 1,663°C.) appeared to have little influence on the internal soundness, but a high casting temperature tended to increase the minute porosity at positions where crystal growth from different surfaces met. Apart from this, casting temperature had little effect on the mechanical properties in the cast condition, and none after annealing. The conclusions set forth in this first report of the Steel Castings Research Committee will serve a useful purpose.

Progress in the United States

The 1933 meeting of the Institute of Metals Division of the American Institute of Mining and Metallurgy showed that there has been no cessation in the striving for improvement of products, in spite of the general trade depression which has been so noticeable in the United States. Announcement was made of a new high-purity high-conductivity copper, introduced by the United States Metals Refining Co., which is already finding wide acceptance in the electrical industry, and also among tube manufacturers where it is providing a competitor to phosphorus de-oxidised copper. This new oxygen-free copper can be bent and twisted well beyond the limits which copper with a little oxygen can withstand, and it also appears to have a much longer life under conditions involving vibration. It is also superior to ordinary copper in that it is practically impervious to the attack of reducing gases at elevated temperature, thus facilitating the process of welding or brazing without appreciable loss of strength. Two papers of a practical nature were given on the problem of gases in metals, one relating to the troubles of the rolling mill and the other to the brass foundry. Dealing with the gas-metal problems of the non-ferrous foundryman, E. R. Darby stressed the importance of pouring at the correct temperature. In the discussion on these papers reference was made to the lack of fundamental data about gases in metals and their effects upon each other. It was pointed out that sulphur is still one of the most important causes of porosity in copper, and that charcoal used as a cover on molten metal was likely to be one of the chief offenders in introducing gases into the melt. In another paper, by W. H. Bassett and C. J. Snyder, a microscopic study of lead cable sheath failures was reported. The authors' method of study involved the examination of the failed sheath under service conditions and the experimental reproduction of similar defects and structures. It was concluded that defective welds could be avoided by maintaining proper lead temperatures and avoiding excessive lubrication, and that all defects caused by inclusions could be avoided by good foundry practice in handling the lead.

Large Castings in Aluminium

IN an interesting paper read before the Verein deutscher Giessereifachleute, Dr. W. Claus has recently suggested that difficulties met with in the production of large aluminium castings may be solved by a proper study of suitable mould materials. Attempts which have been made to solve this problem, surveyed in the light of their theoretical background, fall into three main categories, namely, alloy compositions, the design of moulds, and mould materials. A survey of the principal research indicates that gas inclusions and porousness can never be entirely overcome by attention being directed solely to the alloy properties and to the design of the mould, but rapid cooling, that is to say the provision of good-conducting mould material, conduces to the closest packing of the crystal structure and should therefore give the highest mechanical properties. Without due consideration of this essential principle, all the effort expended along the lines of producing good casting alloys and working out a suitable mould design is in vain. Dr. Claus therefore directed his attention to the different available methods of producing the most rapid crystallisation possible. He first investigated the possibilities of super-cooled sand moulds, but found them to be unpromising. He then turned to chills constructed of different materials built up in different manners. Here very encouraging results were obtained from the use of metallic sands with or without addition materials, as well as from the use of moulds designed to meet special thermal requirements, whose melt-contact surfaces were formed of good-conducting material in finely powdered form. The use of moulds whose melt-contact surfaces are faced with sheet (or of geometrically-fitting elements which give plane wall when assembled), while the bulk of the mould is constructed of either good or bad conducting material, was also suggested.

Contributions to the Metallurgy of Iron and Steel

Annual Meeting of the Iron and Steel Institute

A NOTEWORTHY contribution to the study of inclusions in steels was presented by Professor A. M. Portevin and R. Perrin (Paris), at the annual meeting of the Iron and Steel Institute, held in London, on May 4 and 5. It was shown by the use of the phase rule only, that the study of the inclusions formed in oxidised steel by the addition of elements such as manganese, silicon, aluminium, etc., can be reduced to the investigation of the equilibria between the steel and the slag. Restricting consideration to the inclusions precipitated in a liquid bath of steel during the addition of deoxidants at a given temperature, the relation thus established between the composition of the inclusions and that of the slag in equilibrium demonstrates at once the great complexity of inclusions; there can be as many types of inclusions as of slags. Further, these inclusions are formed in equilibrium with the metal in regard to other elements such as sulphur and phosphorus, which exist in all steels; whilst the elements of addition, such as chromium, tungsten, molybdenum and vanadium play equally their part in the same way as the deoxidants—giving fresh types of inclusions. In addition local concentrations intervene.

Formation of Inclusions

Inclusions formed during the making of the steel, during freezing, and during solidification, may originate by precipitation during the cooling of the steel before any solidification has set in, due to the modification of the equilibria caused by the fall of temperature. Others may be formed on account of the segregation during the solidification in the mould; in effect, these segregates lead to the enrichment in oxides and other matter of the metal which remains liquid longest. Finally, in the ingot, the solidification of the metal does not follow the theoretical law suggested by the diagram; the iron crystals formed imprison particles of liquid, which are withdrawn from the general equilibrium, without the possibility of rising to the surface, whence the formation of minor segregates leading to inclusions concentrated at the crystal boundaries. From this it may well be understood that it is difficult to proceed to the classification of inclusions, given that there should normally be complete continuity in the variation of the compositions. One thing, however, appears to be certain: Inclusions are very complex bodies, like the slags. Therefore, according to their nature and the conditions of cooling, either undercooling will occur, with the formation of glasses, or true crystallisation will take place, giving rise to regular crystals, dendrites and eutectics, the two phenomena being capable of proceeding concurrently.

Attainment of Stable Equilibrium

In ordinary metallurgical furnaces, three factors oppose the rapid attainment of stable equilibrium. First, there is the slow rates of diffusion within the metal and within the slag, a function of their fluidity; secondly, the small extent of the surfaces of contact between the slag and the metal; thirdly, the influence of the atmosphere. The use of the high-frequency furnace suppresses one factor—slow diffusion, in the metal, but not in the inadequately heated slag. This is already a marked advance, but, on the other hand, it leaves entirely untouched the other obstructing factors, which are of even greater importance. The authors are of the opinion that the best process consists of emulsifying the slag in the metal, on the basis of methods already described recently by one of them (Perrin, " Revue de Métallurgie, Mémoirs," 1933, *30*, 4). The extent of the surfaces of contact is multiplied tremendously, and experience has shown that the reactions take place in a negligible period of time. On the other hand, it must be admitted that this method of experimenting is limited to the study of fluid slags, as it is practically impossible to emulsify viscous slags in the metal.

The effect of sulphur and phosphorus on the corrosion of iron was the subject of a paper by L. Tronstad and J. Sejersted, who examined the corrosion of ferrous materials with different phosphorus and sulphur contents in 2*N* sodium chloride, containing oxygen or chromate by measurements of the weight loss and oxygen absorption, as well as by microscopic and micro-analytical methods. They pointed out that in ordinary iron and steel, phosphorus produces no appreciable effect, since it is present mainly in solid solution. A certain number of sulphide inclusions, however, initiate the anodic attack of the metal immediately around them and thus stimulate localised corrosion. A large proportion of the sulphide particles are nearly or completely inactive; the active character of the others may be due to the presence of crevices. The active sulphide inclusions seem to act as cathodes for corrosion of the hydrogen-evolution type, whereas in corrosion of the oxygen-absorption type, which is of greater importance, the cathodic process occurs at the main (uncorroded) area.

Austenitic Steels

A contribution to the study of the properties of austenitic steels was made by L. B. Pfeil and D. G. Jones, who are of the opinion that at the present time the balance of evidence favours the hypothesis that intercrystalline corrosion is due to chromium impoverishment at the grain boundaries resulting from the precipitation at the boundaries of chromium-rich carbides. " There is no doubt," they said, " that carbon diffuses in steel at a much greater rate than chromium; hence with a relatively rapid movement of the carbon to the boundaries it is possible that the chromium content of the boundary films may be reduced even to zero, whatever the chromium content of the metal as a whole." Changes in composition affect the degree of impoverishment in three ways—(1) alteration of the grain-size resulting from a given heat treatment; (2) production of ferrite with a greater solubility than austenite for carbon; (3) alterations in the solubility of carbides or in the rate of solution and deposition of carbides. Failures due to intercrystalline corrosion are unlikely to occur in austenitic-steel structures which are properly heat-treated, as, for example, when a welded vessel is given a final high-temperature anneal and is rapidly cooled. Difficulties should not be encountered in avoiding intercrystalline corrosion in unwelded parts which are subjected in service to heating in the range 550° to 750° C., since by suitable combinations of composition and heat treatment immunity is readily obtainable. Failure, however, is a possibility where welding operations, not followed by the heat treatment of the completed article, involve in certain areas heating to very high temperatures followed by reheating in the region of 650° C., a type of heat treatment almost inevitable when welds intersect.

Structural Changes on Heating

Dealing with structural changes in hypo-eutectoid steels on heating, Sir H. C. H. Carpenter and J. M. Robertson pointed out that just above the upper limit of the critical range steel consists of a system of small austenite crystals. As the temperature is raised, some of these begin to grow and absorb those around them. As the temperature is further raised, the number of growing crystals and the rate of growth increase. Finally all the small crystals are absorbed, and grain-growth practically stops. For a given steel there are two fairly well-defined grain-sizes—(1) that formed when it is heated just above the critical range, and (2) that formed when it is heated to high temperatures. When the steel is in either of these conditions the grain-size does not appreciably increase with the time of heating. At intermediate temperatures it consists of a mixture of large and small grains, and the large grains continue to grow with time. With a given rate of cooling, more ferrite is formed from small-grained than from large-grained austenite. All steels containing between 0.2 and 0.6 per cent. of carbon behave in much the same way during heating, but steels with more or less than this amount behave rather differently. In steel containing 0.1 per cent. of carbon, small austenite grains are produced by heating just above the critical range, but small ferrite crystals are not obtained on cooling. In fact, in steel of this composition the size of the ferrite crystals is not affected by the initial temperature but only by the rate of cooling. This is partly due to the coalescence of ferrite during cooling. In this same steel, however, the size and distribution of the pearlite grains

are influenced to a marked extent by the initial temperature, for each austenite grain gives rise to a pearlite grain.

Recent developments in American blast-furnace design and practice were dealt with by W. A. Haven, who said that for many decades the development of American blast-furnace designs, equipment and operating practices reflected chiefly the influence of a long sustained and steadily growing demand for pig iron. American policy of mass production was followed nowhere more religiously nor with better justification than in this industry. It resulted in the building of such immense plants as Gary, the evolution of the 1,000-ton furnace and an output of 42,600,000 tons in a single year. Gas cleaning has been one of the most effective means of reducing metallic losses, and the improvements in cleaning equipment previously related have now made possible the almost complete recovery of the solid materials carried from the top of the stack. The flue dust so reclaimed, if dry, is carefully collected in cars; if wet, in settling basins or mechanical thickeners. For the most part it is sintered before being returned to the furnaces. Cleaning of the gas, however, may be said to begin in the furnace tops, and the reduction of gas velocities by increasing the area of the stacks at the stock line has been a recent noteworthy accomplishment in this respect. Other than this, however, there has been little change in furnace top design.

Aim of American Designers

The aim of American furnace designers has been to proportion the dimensions of the stacks in such a manner that the descent of the stock would be continuous and regular while offering the least resistance to the upward passage of the gases that is consistent with complete and thorough reduction of the ores. It is common practice to obtain uniform top temperatures of 350° F., or even less, without excessive use of water, although as much of the latter as possible is generally added in order to hold in the dust. The improvement of both the coke and the ore has had much to do with the use of higher blast temperatures, which also distinguishes the present-day American practice from that of a few years ago. Fine ore imposes a definite limit on the temperature of the hot blast, because the replacement of coke in the burden with fine ore cannot be carried on indefinitely without seriously interfering with the permeability of the column of stock. The most outstanding economies that have been attained recently from the use of blast-furnace by-products are those resulting from a more extended and profitable utilisation of blast-furnace gas. One of the most profitable uses of blast-furnace gas is for metallurgical purposes as a substitute for producer or coke oven gas. A direct return to the furnace may not always result from such substitution unless the cost of gas coal is considerably higher than that of steam coal, but the cost of steel can generally be lowered and its quality improved, for straight blast-furnace gas has proved to be a superior fuel for soaking pits and, when mixed properly with coke oven gas, for open-hearths and various types of heating furnaces in the rolling-mills. This procedure, while not new in Europe, was first attempted on a large scale in America by the Steel Company of Canada.

Without detracting from the justly high reputation of the operators of past generations, it may be stated that American blast-furnaces have probably never been under more capable management than they now are. The mechanisation of the equipment has been so extensively carried out that the number of really unskilled labourers about a plant to-day is almost negligible; practically all the workmen perform duties that are strictly routine and in which, therefore, they develop a high degree of efficiency.

External Heat Losses

The external heat loss of a blast-furnace was the subject of a paper by D. F. Marshall, who concluded that, in the past, the external heat loss of a blast-furnace may have been overestimated, and that in a modern furnace with bosh sprays this loss of heat is mainly in the cooling water.

Coke consumption in blast-furnace practice and the effect of removal of breeze was dealt with by D. F. Marshall and R. V. Wheeler, who said that the disadvantages of the presence of breeze in coke charged to a blast-furnace are well-known to all blast-furnace operators, and there appears to be general agreement that, as a means of lessening the amount of breeze, the use of hard cokes, such as those from South Wales and Durham coals, is desirable. Such hard cokes can undergo the normal handling between the coke ovens and the stock level of the blast-furnace without yielding much breeze, whereas softer cokes, such as those from Yorkshire and Derbyshire coals, suffer. The removal of breeze at the furnace is one method of obviating the disadvantage of using a soft coke. It cannot be wholly effective, however, if, as is common, the coke after screening has to be dropped from a considerable height—6 ft. or more—before it reaches the stock level. For the particular blast-furnace studied, it has been shown that the removal of a sufficient quantity of breeze, screened at 1¼ in. or 1½ in., from the coke caused the furnace to drive more easily; incidentally, a by-product, coke-nuts, was obtained which commanded a ready sale.

Speaking of the formation of columnar crystals in steel sheets after normalisation, F. Kinsky pointed out that columnar crystals occur only in soft steel or in decarburised portions of steel sheets. Their origin is dependent on mechanical strain, on the presence of carbon and on heat treatment in an oxidising medium, but the growth of the crystals is a function of the length of time of soaking. In analogy to the recrystallisation of mechanically strained steel, the largest columnar crystals may be obtained only after a definite degree of deformation (3 to 4 per cent.), depending upon the original size of the grains. An oxidising atmosphere favours the grain growth; carbon, phosphorus and non-metallic inclusions hinder it. Carbon-free steel which has undergone slight deformation has the greatest tendency to form columnar crystals when the annealing temperature is nearest to the upper critical point. The most favourable annealing temperature for carbon steel is the lower critical point if heated in a neutral atmosphere. In an oxidising atmosphere the temperature depends upon the rate of decarburisation; it usually lies above 1,470° F. (800° C.). His investigation dealt with the abnormal growth of crystals of a columnar character in normalised steel sheets, and gave hints for its prevention. He was of the opinion that the formation of large columnar crystals is due to small thermal intercrystalline strains set up by a rapid passage through the region of maximum segregation of α solid solution.

Steel Merger Scheme

Letter to Debenture Holders

THE scheme of amalgamation between Dorman, Long and Co., Ltd., and the South Durham Steel and Iron Co., Ltd., is not yet ready for publication, but a circular letter to the holders of the 5½ per cent. first mortgage redeemable debenture stock of Dorman, Long and Co. was posted on April 28, stating that the full details would be submitted to the stockholders and shareholders at an early date. The letter, which is signed by Mr. S. W. Rawson, the secretary, states that "As foreshadowed by the chairman at the last annual general meeting, the scheme will require substantial modification in the structure of the company's capital, and this will include the 5½ per cent. debenture stock. Although the negotiations have not yet been completed, it is evident that the directors must now ask the stockholders to leave the interest on the stock for the half-year ending April 30, 1933, to be dealt with under the scheme, the meetings to consider which will be called in accordance with an order of the Court as soon as the scheme is ready for submission."

The interest on the 5½ per cent. debenture stock, which was payable on May 1, amounts to approximately £140,000, there being over £5,000,000 of such stock. There is no doubt that the directors had been anxious to place the details of the proposed reconstruction of the company's capital, and the terms of the provisionally agreed amalgamation with the South Durham Steel and Iron Co., Ltd., in the hands of the stockholders and shareholders before May 1. It is only a month since the provisional agreement between the boards of the two companies was reached, and the interval which has since elapsed has proved insufficient to enable the complete details of the scheme to be issued before the debenture interest falls due. The circular letter has therefore been issued, and amounts in effect to a request to the debenture holders to exercise patience for a few days, when the complete scheme will be available.

Ternary Alloys of Lead

An Improved Material for the Plumber

THE possibility of saving from 20 to 30 per cent. on the cost of much of the lead used for building purposes is suggested by a research report issued by the Department of Scientific and Industrial Research. This report, Building Research Special Report No. 19, "Ternary Alloys of Lead: their Use in Buildings" (H.M. Stationery Office, 9d. net), deals with the use in building of two new ternary alloys of lead recently introduced by the British Non-Ferrous Metals Research Association. The new materials, known as B.N.F. Lead Alloys Nos. 1 and 2, are formed in one case by adding to the lead ¼ per cent. of cadmium and ½ per cent. of antimony, and in the other case by adding ¼ per cent. of cadmium and 1½ per cent. of tin. These alloys were originally developed by the B.N.F.M.R.A. to overcome troubles due to the cracking of lead used for the sheathing of electric cables. This trouble was met with in places where the cables were exposed to excessive vibration, as for example on board ship, in submarine and aerial cables, and in railway service on bridges and in tunnels. It has also been known to occur in the transport of new cable overseas, several instances being reported where drums of new cable shipped from this country to New Zealand or South America, have arrived at their destination with the lead sheathing cracked owing to the vibration of the ship. The new alloys, however, have at least four times the resistance to vibration of pure lead, and have therefore proved a complete solution of this difficulty. Their industrial significance will be evident when it is mentioned that 80,000 tons of lead are used annually in Great Britain for cable sheathing.

In dealing with their use in building, the report points out that the superiority of the alloys in their resistance to vibration should make their use specially advantageous in buildings exposed to vibration caused by increasing road traffic or the increasing introduction of mechanical appliances of all kinds. Besides, however, resisting vibration, the B.N.F. alloys are about one-third stronger than ordinary lead in other respects. Their use has accordingly been approved for water pipes above ground inside the building in weights 30 per cent. lighter than ordinary lead pipes. Exhaustive tests are being carried out on the frost resistance of the new materials, but so far these tests merely show that the frost resistance of the thinner B.N.F. alloy pipes is the same as that of the thicker lead pipes of equal strength which they replace.

The B.N.F. alloys are slightly more expensive per ton than lead. Assuming lead costs £10 per ton, and that, owing to their superior mechanical strength, two-thirds of a ton of the alloys can replace one ton of lead, then the saving in using the cadmium-antimony alloy at £10 11s. per ton would be £3 per ton on the lead used, and in the case of the cadmium-tin alloy at £12 6s. per ton the saving would be £1 16s. per ton of lead used. The report points out, however, that in building, resistance to corrosion is often more important than mechanical strength. Experiments have shown that the resistance to corrosion of the B.N.F. alloys is at least equal to that of pure lead. The alloys, it is stated, lend themselves perfectly to soldering and plumbing.

Refractory Oxides for Crucible Manufacture

A Survey of Properties

The following notes are based on information supplied by Bush, Beach and Gent, Ltd., who are now marketing special grades of oxides for stringent chemical and thermal requirements.

FOR some time past it has been known that many oxides have a very high degree of refractoriness as measured by their melting points. Not all of them, however, are suitable for making crucibles and similar products. Lime, for instance, cannot be used, because in an atmosphere containing H_2O and CO_2, it absorbs water and carbonic acid, thus changing and losing its firmness of form. Only oxides unaffected by atmospheric conditions can be used for the purposes in question. These oxides are not only of importance because of their highly refractory nature. The particular chemical character of any oxide controls the special chemical properties of the articles made from each oxide; properties which must be sought for in vain in products made from the materials previously employed.

Aluminium Oxides

Aluminium oxide Al_2O_3, having a melting point of 2,050° C., is used in its pure form for the manufacture of refractory products. The material, roasted at a very high temperature, possesses many valuable qualities. From it can be manufactured protective tubes, crucibles, etc., which are gas-proof up to about 1,950° C. It is quite unaffected by reducing gases such as carbon monoxide, hydrogen, etc. Acid and alkaline fusions, even with NaOH and Na_2O_2 can be carried out in these alumina vessels up to red heat without damage to them. The corrosion due to melting silicate glasses is astonishingly small; in fact it is even possible to melt quartz in such highly sintered vessels without the latter going into solution. Moreover, the evaporation of hydrofluoric acid hardly affects it. On account of the high reduction potential of aluminium, the melting of various readily oxidisable metals can be carried out without any risk of the melt being contaminated by the material forming the crucible. The high electrical resistance of hard-fired alumina, even at high temperatures, united with a good capacity of resistance against changes of temperature, make it a material particularly suited for use in wired articles, as for instance, those used in wire electric heating-resistances.

Ordinary spinel, $MgO\text{-}Al_2O_3$, resembles aluminium oxide in many respects. With a melting point at 2,135° C., it is more highly refractory than alumina. The neutral character of this combination, particularly at high temperatures, comes more into evidence than that of alumina, as the latter takes on the properties of an acid. In consequence of its very low heat conducting properties, spinel is more susceptible to sharp changes of temperature than alumina, but against reducing agents, spinel equals alumina as regards power of resistance. Vessels can be made quite as gas-proof as those made of alumina. They are extremely useful for various salt and slag-like substances, for precious and ordinary metals of high melting point, as well as in the form of protective tubes possessing very low heat-conducting powers for high temperature pyrometers.

Beryllium Oxide

Pure beryllium oxide, BeO, melting at over 2,500° C., is a valuable ceramic raw material. Articles can be made from it which are perfectly gas-proof. On account of its excellent properties as a heat conductor, this material is eminently insensible to very sharp changes of temperature. For this reason the use of beryllium crucibles in high frequency furnaces is particularly successful. Caustic alkalies melted by direct flame do not affect such vessels as they do those of alumina, though they are very susceptible to the action of acids. The chemical resistance to reducing agents is higher than in the case of alumina so that common metals and alloys with high melting points, zirconium metal and beryllium itself can be melted without any risk of causing damage to the crucible: on the other hand, oxides such as alumina, magnesia, etc., readily form fusible slags with beryllia at high temperatures, but zirconia and beryllia can be left in contact up to about 1,900° C. without causing the formation of slag. Even at very high temperatures carbon hardly affects beryllia.

Zirconium Oxide

The melting point of zirconium oxide, ZrO_2, is about 2,700° C. Vessels made of it can be used up to temperatures around 2,500° C. In its chemically pure form this material

—contrary to all the other oxides mentioned here—cannot be used ceramically. Small quantities of other high refractories must be added, which do not lower the refractory qualities of the material, but render the use of it for ceramic purposes possible. In contact with alkaline and acid substances, even at very high temperatures, these vessels are distinguished by their very high powers of resistance. Many basic slags and glasses may be melted in them for hours at a temperature above 1,700° C. without the crucible being appreciably injured. At high temperatures, zirconia is only affected superficially by carbon, zirconium carbide being formed. Vessels made of zirconia are comparatively sensitive to changes of temperature, as the expansion-coefficient of the material is high and its thermal conductivity but small.

Magnesium Oxide

Pure magnesium oxide, MgO, does not melt under 2,800° C. The manufacture of the dense substance from practically pure oxide is a feat that has only just been achieved. Although the thermal coefficient of expansion of magnesia is very high, articles made of this material are comparatively insensible to changes of temperature, because of the compensating effect of its high heat-conducting properties. It has a high chemical imperviousness to basic materials, even at very high temperatures. In a strongly reducing atmosphere and in the presence of carbon, it is comparatively volatile at a high temperature; in oxidising and neutral atmospheres, on the other hand, vessels can be employed up to a temperature of 2,500° C. without noticeable volatilisation.

The melting point of thorium oxide, ThO_2, is around 3,000° C. Thoria products are made from fine grained pure raw materials, roasted at a temperature of about 2,000° C., and show a good degree of density. The chemical resistance of these articles, for instance against basic compounds, is very considerable. They can be used at a temperature of over 2,500° C., but carbon affects the material by forming a coat of carbide. As thoria possesses a high coefficient of expansion, products made of it are affected by sudden changes in temperature.

All precious metals can be melted in crucibles made from any of the foregoing oxides. The selection is only dependent on the temperature it is necessary to attain. Practically the same applies for other metals, which are oxidised with comparative difficulty, for example, nickel. Readily oxidisable metals, and those having very high melting points, *e.g.*, zirconium, can be melted with advantage in crucibles of difficultly reducible material, for instance, beryllia. It is recommended to use a protecting atmosphere or vacuum, instead of air or carbon dioxide to protect the crucible material from being affected by metal oxides. In this connection it is of importance to mention that the melting of iron and its alloys in an oxidising atmosphere results in the formation of FeO which affects the most different refractory oxides at high temperatures, owing to solution and slag formation.

Some Recent Metallurgical Patents

Manufacture of Tool Steel

ALLOYS, particularly suitable for making cutting tools, may contain 20 to 35 per cent. of cobalt, 15 to 30 per cent. of tungsten, or molybdenum, or both tungsten and molybdenum, 0.5 to 3 per cent. of vanadium, and 0.2 to 0.6 per cent. of manganese, the balance being iron. Carbon and chromium are regarded as impurities and should be kept as low as possible. In an example given in Specification No. 387,322, of C. P. Miller, the alloy is prepared by melting in a furnace free from carbon, and casting. The ingot is reheated, worked, and annealed to render it machinable. A further heat treatment at 1,000° to 1,400° C. followed by quick cooling renders the alloy tough, in which condition it may be light machined to the desired shape.

Magnetic Iron Alloys

MAGNETIC iron alloys for use in the construction of electrical apparatus, containing 0.1 to 6 per cent. of silicon and 0.1 to 6 per cent. of arsenic, are described in Specification No. 386,220, of the Westinghouse Electric and Manufacturing Co. The alloys may be made by adding arsenic or ferro-arsenic to molten iron or by passing a stream of arsenic hydride or arsenic vapour into molten iron, the silicon being afterwards added as such or as ferro-silicon; or an alloy or compound of arsenic, silicon, and iron may be added as the iron is being poured into the ladle. Rolled sheets of the alloy may be annealed by heating in air, a neutral atmosphere, or hydrogen, for 2 to 8 hours at 900° to 1,100° C. In making laminations, the sheets may be annealed for several days at 900° to 1,100° C., cooled in the furnace, punched, and re-annealed for a similar time at 700° to 800° C.

Treating Metallic Surfaces

THE action of an acid phosphate solution on metals, *e.g.*, iron, steel, zinc, or magnesium, is accelerated by the addition of an oxidising agent capable of diminishing or removing the hydrogen blanket generated at the surface of the metal. According to Specification No. 386,739, of the Metal Finishing Research Corporation, when coating iron or steel, or when using a solution containing ferrous phosphate, only oxidising agents which do not react to any great extent with the ferrous iron in the bath, such as nitrates, nitrites, sulphites, nitric acid, sodium tungstate, uranyl acetate, chlorates, bromates, iodates, or organic compounds such as methylene blue, can be employed: in other cases common oxidising agents such as air, hydrogen peroxide, manganates, permanganates, manganese dioxide, chromates, dichromates, and quinone are also satisfactory.

Chemically Neutral Alloys

CHEMICALLY neutral or stainless chromium-nickel steel alloys containing not more than 0.48 per cent. of carbon and also one or more of the elements niobium, tantalum, hafnium, or rare earth metals such as cerium, thorium, lanthanum, yttrium, neodymium, samarium, are described in Specification No. 386,690, of F. Krupp Akt.-Ges. The alloys may contain 12 to 40 per cent. of chromium, 7 to 25 per cent. of nickel, and up to a total of 10 per cent. of the other elements. It is advantageous to select a total quantity of the added elements, at least twice as great as the carbon content of the alloy, the whole of the carbon dissolved in the austenitic foundation mass then entering into stable chemical combination with the added element or elements and the austenitic form of structure of the alloy being retained even when it is subjected to heating at about 500° to 900° C.

Beryllium Alloys

A PROCESS for the production of alloys, or combinations of metals of any kind, may consist in separating a metal from its combination with an acid radical consisting of one kind of atom, *e.g.*, a halide, by a second metal which is to be alloyed with the first metal, the second metal entering into a volatile combination with the acid radical of the first metal compound. If a chloride of the first metal is to be reduced it may be prepared by the direct chlorination of the raw ore. In an example given in Specification No. 386,621, of W. Kangro and A. Lindner, beryllium chloride vapour is fed into a receptacle containing aluminium. Aluminium chloride is formed and escapes with some unreduced beryllium chloride from the reaction chamber, the reduced beryllium alloying with the excess of aluminium on the application of more heat. The beryllium particles may also be fused together instead of being alloyed with an excess of aluminium. The working conditions may be so chosen that the salt to be decomposed is partly solid in the reaction chamber, and the yield of reduced metal may be controlled by adjusting the conditions of temperature and pressure.

Chemically Pure Magnesium

BY repeated sublimation of magnesia at 600° C.—which is 50° C. below the melting point—under a pressure of 0.01 mm., Herenguel and Chaudron ("Comp. rend.," *195*, 1272) have obtained the metal in the completely pure condition, including freedom from silicon. After re-melting the metal at about 1 atmosphere pressure in an atmosphere of argon at 650° C., the metal is obtained in a hardness of 29° Brinell.

Metallurgical Section

June 3, 1933

Recent Contributions to Metallurgy

PRACTICAL problems involved in the American practice of commercial electro-plating on aluminium were discussed by H. K. Work in a paper presented at the recent Birmingham Conference of the Electro-depositors' Technical Society. Under certain conditions, deposits may be applied directly to a smooth aluminium surface, but preliminary treatment with the application of a nickel coat before the desired plating is preferred. After a satisfactory nickel plate has been applied over a specially roughened surface, almost any type of electro-deposit may be superimposed on the nickel by following the usual plating procedure. Roughening is effected by an etching operation; it is not sufficient to produce such a surface by sand-blasting, as the "pits" must have a special undercut shape so that the subsequent deposit is securely anchored. It is possible, however, to apply zinc to an unroughened aluminium surface; such platings have found commercial value for electrical contact surface and, to a lesser extent, as a protection against corrosion. Chromium may also be deposited direct. The nickel plating of aluminium, however, differs markedly from the plating of other metals in the special roughening of the surface of the metal. For etching commercially pure metal a dip containing nickel chloride and hydrochloric acid is used. During the process certain portions of the aluminium seem to be dissolved selectively, so that there are large undercut "pits" with relatively smooth areas between them. Once the metal has been properly etched the electro-plating of the surface is relatively simple, but certain conditions have to be fulfilled in the etching bath. The chief variables are nickel content of the bath, acidity and temperature, and of these, nickel content has been found to be the least important. Rate of etching depends largely on the acidity of the dip, whilst a rise of 10° in temperature reduces the optimum time of dipping by 50 per cent. The etching of castings, however, differs from the etching of wrought material, for here the etching solution consists of strong nitric and hydrofluoric acids without added metal. This solution does not appear to depend on electrolytic action to accomplish the pitting, but rather upon its solvent action.

Age Hardening in Metals

X-RAY studies have yieded much information upon the ageing and age hardening of metals, and it is now possible to explain many of the phenomena. At the annual meeting of the Society of Chemical Industry on May 1, Dr. C. H. Desch, head of the Metallurgical Department, National Physical Laboratory, pointed out that in the age hardening of steel a nitride appeared to be precipitated from solid solution and a definite crystallographic relationship seemed to exist between the solid and the precipitate. He was of the opinion that the ultimate solution of the problems of ageing and age hardening would be largely geometric, that is, they would be concerned with the movement of atoms and their ability to migrate and form nuclei. Slides were shown to illustrate the phenomena described, and typical examples were given of the beneficial application of the results so far obtained. One special example was given from the electrical industry, where the tensile strength of austenitic steel was low, but although cold working led to an increase in tensile strength this factor could not be employed as the steel became magnetic, the *gamma* condition of the iron changing to *alpha* condition. Material which could be worked to increase hardness without affecting the non-magnetic condition was found to be produced by the addition of a compound of molybdenum or titanium, having high solubility in the steel at high temperatures and low solubility at low temperatures. Steels now employed for transformer work contain very little nitrogen and do not show ageing, but although nitrogen appeared to have the greatest effect, other elements in solid solution—such as oxygen and carbon—could also bring about the phenomena in mild steels. As the quantities involved are very small, important changes are possible in the properties of the metal by the addition of exceedingly minute amounts of other elements, and it is in this aspect that a great deal of refined X-ray technique has been brought to bear upon the subject.

Properties of Grey Cast Iron

DATA concerning the effects of metals and alloys on the physical properties of grey cast iron was recently placed on record by W. H. Spencer and M. M. Walding in the "Transactions of the American Foundrymen's Association," (Vol. 4, No. 1, p. 491). The authors of this paper are associated with the American Cast Iron Pipe Co., and it was because of obtaining certan results in the properties of iron castings—which the usual chemical tests and melting, moulding and other practices have not explained—that they conducted a series of experiments to determine what effects could be attributed to elements sometimes found in scrap iron. The materials added were lead, antimony, tin, bismuth, cadmium, arsenic, ferro-arsenic, copper, brasses and bearing metal. Two types of cast iron, used as base metals, were melted and the additions made in the ladle. Results on test bars with the alloy additions were compared with test bars made without the alloy additions, and the results indicated important effects on the irons, varying with the two types selected. Detailed analysis and effects

are recorded in the form of tables and charts. The chief conclusions drawn from this investigation is that lead, antimony, tin, bismuth, cadmium and bearing metal lowered the transverse and impact strength. Arsenic (as metallic arsenic or as ferro-arsenic), copper, bronze and brass either raised or lowered the transverse and impact strengths, depending on the amount added, the nature of the cast iron, and the amount of agitation and oxidation taking place in the ladle. High ultimate modulus or stiffness usually was associated with lower impact strength, although there was no definite ratio; here lead was the outstanding exception, ultimate modulus and impact strength giving practically parallel lines. Widely different and even contradictory results on the two irons were obtained in the effects of antimony and bismuth on ultimate modulus and hardness; metallic arsenic on transverse strength; ferro-arsenic on transverse strength, ultimate modulus and hardness; copper on transverse and impact strengths and ultimate modulus; brass on ultimate modulus and Brinell hardness. The depth of chill on the iron was also greatly affected by some of the additions, especially in those cases where other results were far from normal.

Cheaper British Steel

THE opening of the new coking plant at the Irlam works of the Lancashire Steel Corporation, Ltd., on May 9, marks another important step towards the manufacture of cheaper British steel. The Lancashire Steel Corporation, it will be recalled, was formed in 1930 to take over the control of the Partington Iron and Steel Co., Ltd., Pearson and Knowles, Ltd., and the Wigan Coal and Iron Co., Ltd., all of Lancashire, a scheme being drawn up for the re-arrangement and consolidation of these businesses as one manufacturing unit. In addition, the Corporation now owns the share capital of Rylands Brothers and the Whitecross Co., Ltd. As the result of this amalgamation the coke ovens, blast furnaces, and steel works of the combine have been centralised at Irlam, and the old Partington and Wigan ovens have been closed down. The new coking plant consists of 51 Becker ovens capable of producing 5,000 tons of coke per week; the blast furnace plant has a capacity of 7,000 tons of iron per week. The raw coal, much of which will be supplied by the Wigan Coal Corporation, Ltd., is fed to the coal washery through a de-dusting plant, the washery being fully equipped with de-watering sieves to reduce the moisture content of the coal and so increase the efficiency of the coking process. Blending is also effected with great thoroughness, a revolving table being placed beneath each of the blending bunkers to regulate the exact rate of discharge on to a common receiving conveyor which carries the coal to the crushing plant. The surplus gas from the ovens is utilised in the open-hearth furnaces and in the re-heating furnace, thus adding to the fuel economy effected. The coke is received in a coke-quenching car, which is electrically hauled to a quenching station of the recirculating type where it is sprayed with a predetermined quantity of water. After cooling on an inclined wharf it is passed to the screens, where it is graded in three sizes. Coke above $1\frac{1}{2}$ inch, containing only about 1 per cent. of moisture goes to the blast furnace bins; that between $1\frac{1}{2}$ and $\frac{3}{4}$ inch is sold for domestic purposes, and material below $\frac{3}{4}$ inch is classed as breeze. It will therefore be seen that everything possible is done to ensure the manufacture of coke of the quality most suited for blast furnace operations.

Regenerators for Open Hearth Furnaces

THE Institute of Fuel has done the steel industry a noteworthy service in publishing from time to time outstanding papers upon the subject of regenerators for open hearth furnaces, and at a recent meeting, three further papers were presented upon this subject by Dr. V. H. Legg, Dr. H. Trinius and H. Southern. Discussion upon these papers fell into three categories: the examination of details, such as methods of experiment; the purely theoretical discussion of the subject, and the practical operator's opinion. The papers as a whole presented certain conclusions upon regenerator design and upon the method of calculation. These conclusions were necessarily based upon experiments conducted under conditions far more nearly approximating to the ideal than to the real. The mathematical calculations were likewise based upon ideal conditions, and took no account of such vital matters as the necessity for maintaining the atmosphere of the furnace to suit the melt, of the blockage of the regenerators by slag and dust, and so forth. For this reason there was some disposition among the practical men to belittle the work as being impossble to apply in practice. As Mr. Sarjent said, you only get from the mathematical mill what you put into it. It is impossible to take into account in such an investigation the varying conditions of practice. Mathematical simplifications are essential if the mathematical computation is not to become unmanageably complicated. Experimental simplifications are essential in order to separate some of the variables. The result that may be expected is not necessarily a final and complete guide to regenerator design but a set of guiding principles upon which regenerator design may be based. How far these may be applied by the designer and what factors of safety are necessary is the function of the practical engineer to discover.

Recovery of Waste Heat

THE discussion showed a difference of opinion regarding the value of waste heat boilers in conjunction with open hearth furnaces. The recovery of waste heat in the form of steam has made so much progress in other industries that the relative lack of progress in this direction in the steel industry is a matter for surprise. Even the old bee-hive coke ovens collect their hot burnt gases into a common flue and pass them through a boiler at the farther end of the battery. The efficiency of the same practice applied to modern gas works retorts is common knowledge, and it appears strange that temperature and thermal conditions which in a gas works are considered ample justification for the installation of waste heat boilers, are regarded in the contrary light in the steel works. The problem of increased efficiency of regeneration obtained at an increased cost versus less efficient regeneration coupled with waste heat boilers is one which might well and profitably be the subject of a debate between the Iron and Steel Institute and the Institution of Gas Engineers. We commend the idea to the Institute of Fuel.

The Working-up of Poor Cupriferous Ores

Copper Extraction and Refining

MODERN systems of extracting and refining copper appear to have altered somewhat in view of the importance attached to the recovery of the more precious metals. This same state of affairs is evident in the extraction of many other metals, and it will be observed that the tendency is to make use of electrolytic methods either during the process of recovery, or at the final refining stages. Although it is well known that many copper ores are even practically free from silver, the electrolytic method of refining copper has become almost universal.

A perusal of the statistics of copper refined throughout the world will reveal that most of it is now refined by the electrolytic system, whilst the direct smelting of the metal shows a consistent decline from year to year. A similar state exists with many of the other metals, but to a lesser degree, whilst there are exceptions in the case of some metals, for example, antimony, which show little possibility of discontinuing the smelting practice. Until within the past few years, these metal extraction works were laid out simply for the recovery of the pure metal contained in the ore, but to-day most of the up-to-date works have a subsidiary plant wherein to extract and recover the by-products as far as possible, rather than allow them to be disposed of for treatment elsewhere.

Preliminary Treatment

This may be confirmed by following the reports of the numerous large metallurgical concerns throughout the world. Whereas silver, gold, cadmium, bismuth, arsenic, etc., were dispatched to outside firms, and showed a small profit for the disposal of the raw material, to-day these profits show a vast increase as a result of the by-products being recovered and refined on the premises. Metals still abound on the scrap market, such as copper, nickel, lead, and even tin, which contain appreciable amounts of valuable by-products, and which it would pay to refine electrolytically. Authorities on nickel extraction have long advocated the necessity of applying electrolysis so that the small amounts of platinum and iridium present may be recovered and further refined to their respective pure metallic conditions.

Much of the copper extracted in this country is obtained from poor cupriferous ores, or from pyrites mined in Spain. The first stages of the extraction process have not altered much within the past thirty years, whilst the principles of this extraction date back to over half a century. The final stages in which the copper is electrolytically refined have been materially improved on, and by-products are now recovered in the metallic state.

The pyrites from the mines are first disposed of to local sulphuric acid works who burn out the sulphur almost completely, and the cinders are returned to the copper extraction works. Here the burnt ore is mixed with a proportion of common salt, ground to a fine powder in mills, and roasted in large roasting furnaces specially constructed for the purpose. The gases from these furnaces are led up coke-filled towers which act as condensers, and the acid liquor recovered is used for extracting the soluble matter in the ore. After cooling, the roasted ore is placed in a number of wooden tanks and digested in the crude acid liquors until no further extraction is possible. The lixiviation is then continued with the assistance of hot water until all copper has been washed out.

The Claudet Process

The liquors are then led into large settling vats lined with vitreous slabs, where the lead is allowed to separate out as sulphate. As a result of the method of conducting the roasting, the liquors are composed of a mixture of hydrochloric and sulphuric acids, and the impurities thus extracted from the roasted mass are considerable. At this stage the Claudet process, which was discovered some fifty years ago is introduced, and is still applied to the present day, but in many cases wet copper extraction has been carried out without any efforts being made to recover the small quantity of silver present, as the Claudet system was considered too much trouble for the silver which could be obtained.

The later electrolytic copper refining process recovers all silver and other by-products whether present in small or greater quantity, and also provides a much purer copper. The direct smelting system holds the advantage that it is much more rapid, and the lay-out of the plant is not so expensive. With the progress made recently in the use of the different metals recovered from the by-products, the demand for the latter has increased, and thus the electrolytic system has become widely popular. The treatment of the copper liquors after the Claudet process consists of precipitating the copper with metallic iron. If the Claudet process is omitted, the action of the iron is to include silver in the copper sludge, and as iron deposits silver before copper there is little fear of any loss of the former being sustained. In practice, the precipitation with iron is comparatively simply conducted, and the conditions which are best suited to ensure rapid and thorough separation has been dealt with by numerous authorities in earlier times. The reddish-brown sludge is washed through a grating with water, and any small pieces of metallic iron are removed by means of hand picking. The sludge is then dried on large open steam-heated driers, from whence it is transferred to the smelting furnaces.

Reduction of Precipitated Copper

When the silver has been recovered by the Claudet, or other system, the smelting consists of refining the dried sludge to the pure copper ingot by a modified application of the Welsh method. In the case of sludge containing silver, the smelting process is further modified so that the product retains the impurities, and simply converts the dried precipitate to the crude metallic state which is suitable for electro-refining. With the former process, the smelting has to be conducted in different stages, and the slags from each, returned for reclamation purposes. In the latter process, the precipitate is reduced to the metallic state as rapidly as possible, without any attempt at refining, and the crude copper is run into anode moulds. The plant used in one works for this practice consisted of one reverberatory furnace, and a small cupola. In the reverberatory furnace the copper precipitate was treated with lime and coal dross whereby the copper was reduced to the crude metallic condition. The slags from this were returned to the cupola and smelted with the addition of a little of the raw pyrites used for sulphur extraction. This gave a poor slag, despatched to the waste heap, and a poor copper matte which was used up in supplying sulphur to the roasting furnaces, when cinders from the sulphuric acid factories had been roasted too "sweet." In the direct smelting process, in which rich copper ores were also worked, this poor copper matte is transferred to the first furnaces, or in some cases has to be roasted, which is considered a wasteful process.

Electrolytic Experiments

The crude copper cast into the anode moulds, is apt to have many defects which may adversely affect the subsequent electrolytic refining. It should perhaps be added here that numerous unsuccessful attempts have been made in the past to electrolyse copper matte itself, with the object of obviating the refining system in-toto. Such a process would exert a revolutionary influence on all copper recovered throughout the world, since it would then only be necessary to directly smelt poor ores to copper matte, and electrolytically refine at the mine head. The process has been worked experimentally for the past fifty years, but does not appear to have established anything resembling confidence, although all kinds of exaggerated statement have been made to the contrary, based on small scale research work. The refining of crude copper to the pure electrolytic metal, however, is soundly established, and works with unfailing consistency. Amongst the chief practical points of importance in the reduction of the precipitated copper, is the necessity for removal of all gases from the metal prior to casting into the anode moulds.

The work is left in the hands of an operative whose practice more resembles that of a melter than a smelter. The copper precipitate from the driers is usually made slightly damp by sprinkling water over the mass, to prevent loss by

dusting. This slightly damp mass, together with its calculated proportion of lime and coal dross is weighed off, and thoroughly mixed by shovelling into appropriate heaps. It is then charged on to the hot bed of the reverberatory furnace, which is carefully tended, and when all metal has been reduced the slag is removed. The green molten mass of copper is examined by the melter who applies several physical tests which show the stage which the metal has reached.

Anode Casting and Electrolysis

Previously reduction was effected by poling systems, and later substituted by direct addition of carbonaceous matter, coal dust, etc., processes which are still in use. Exception, however, was taken to the necessity for further slagging arising from the silica of the ash combining with the metallic oxides present in the molten bath, and thus forming a fresh skin on the surface of the metal. This resulted in a new departure from former practices, based on the assumption that any additions made will be subsequently removed during the electrolysis. The additions made are of a very unusual character, and are generally more or less kept private by the refiners.

The result is that the copper containing its numerous impurities is obtained in dense and sound metallic condition, and is cast without difficulty into the anode moulds. A mechanical device is used which permits of the moulds being accurately filled without loss by overflow, and automatically brings the different moulds into position in their proper rotation without loss of time. In this way, the furnace is tapped almost as rapidly as when tapping into ingot moulds, and the anodes are of definite shape and size.

The electrolytic refinery consists of a series of lead-lined tanks supplied with current from a generating set, the whole plant resembling that of an ordinary plating shop on a large scale. The cast anode has a lug at the top with a hole (or in some cases a rounded protuberance) so that it may be rapidly slung into position in the electrolysis bath. The cathodes usually consist of copper sheets known as starting sheets whilst the electrolyte is maintained at 10 per cent. sulphuric acid, and 16 per cent. copper sulphate (4 per cent. copper). Whilst American practice shows that a wide range of currents may be successfully used, in this country the older practice of using 10 amps. per square foot appears to be adhered to. The electrolyte is kept warm by having it pumped to an overhead tank which is heated by steam coils, from whence it returns continuously to the electrolysis tanks.

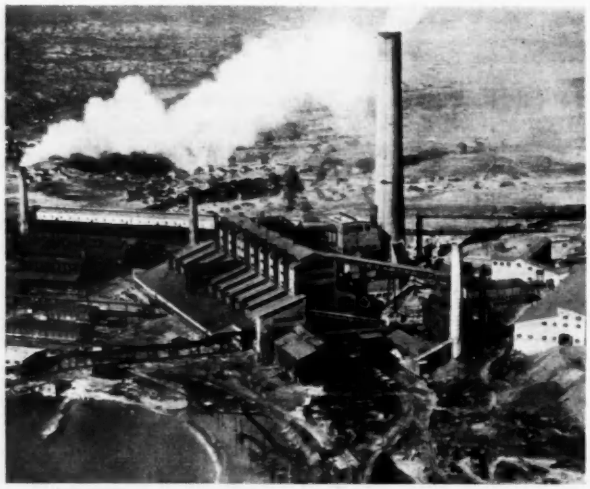
Control of the Electrolyte

This is done by making use of a storage tank with cistern arrangement which operates a mercury switch, which in turn causes the centrifugal pump to function. The temperature is maintained at about 50° C. and when it is known that an appreciable amount of silver is present in the copper, a small addition of hydrochloric acid is made to the electrolyte. In general practice the electrodes are 1 to 1½ in. apart, and the conditions of slinging them in the approved proximity to one another has much to do with the uniformity and smoothness of the resulting copper cathode. The slimes which are separated as a result of the action of the current contain besides silver, small quantities of numerous other metals. These are collected during the process, principally by their settling out in the bottom of the tanks, whilst that which floats in solution is recovered by causing it to pass through a small filter press. After drying, this residue is subjected to an extraction process whereby the different by-products are separated, whilst the precipitated silver is simply melted on to lead in a "test" hearth and cupelled in the ordinary way, to pure silver.

Fifty Years of Nickel

Anniversary of the Discovery of Ore in Ontario

THE recognition of nickel as one of the great metals of modern engineering and industry followed directly from the discovery, in 1883, of the large ore deposits near Sudbury, Ontario, and from the research which has since been carried out in both mining and metallurgy by the industry founded on those deposits. A formal observance of this fiftieth anniversary was made at the thirty-fourth annual meeting of the Canadian Institute of Mining and Metallurgy, held in Toronto during the first week in April, when Mr. Robert C. Stanley, present of the International Nickel Company of Canada, Ltd., spoke to the Dominion in a speech broadcast from the annual banquet.



Copper Cliff Smelter, Ontario, where Ore is concentrated to a Matte containing about 80 per cent. Nickel and Copper.

Mr. Stanley brought out in his address that on its discovery in 1751, nickel became the thirteenth metal element to be recognised, and that to-day it is one of the seventy known metals and ranks ninth in quantity consumed. From the point of view of mining, the finding of the ore near Sudbury may appear to have been a chance discovery; for there were no preliminary geological studies, no field expeditions or diamond drilling. In reality, however, this discovery was directly due to the vision, the courage, and the energy that went into the projection of the Canadian Pacific Railway's trans-continental line. As the construction gangs blasted their way westward from Sudbury a cut through an outcrop of gossan exposed the copper-nickel ore upon which an industrial structure is still being built. Naturally enough the first phases of the exploitation that followed the discovery of the ore were in terms of copper, since the industrial uses of that metal were generally understood at the time. However, the nickel content could not be ignored, though it baffled the metallurgists then, just as it had done those of the eighteenth century. Nevertheless in due course the smelting and refining problems were solved and so much nickel became available that the paramount problem since then has been one of discovering and developing sufficient industrial outlets for the metal.

At another session of the Institute's meetings, Mr. E. A. Collins, assistant to the general manager of the smelter at Copper Cliff, Ontario, gave an illustrated talk on the early days in Sudbury, in which he brought out that the original mining claim had been bought from the Crown by prospectors for $1 an acre, and that the mining district developed from this claim had already produced nickel, copper, platinum and other metals to an aggregate value of more than half a billion dollars.

Brazing Alloys Containing Silver

Their Technical Properties and Industrial Utility

In spite of the fact that soldering and brazing have been practised since very remote times, it is only quite recently that scientific consideration has been given to the solders themselves, and to the technique of the soldering and brazing operations. In the developments of jointing practice, silver-alloys have played a very prominent part, and research and experience have proved beyond doubt that they possess characteristic properties which give them decided advantages over the ordinary brazing brasses. The scientific development of silver solders along these lines as adopted by Johnson, Matthey and Co., Ltd., and their affiliated company, Oakes, Turner and Co., Ltd., marks a definite progressive stage in the production of brazing alloys suitable for modern industrial requirements. Jointly, these two firms have now issued a brochure to make the merits of brazing alloys containing silver more widely known.

Fusibility and Corrosion Resistance

Two of the chief characteristics of silver solders are the relatively low temperatures at which they melt, and their remarkable fluidity when molten. Melting points range from 670° to 850° C. whereas the melting points of the brazing brasses range from 870° to 1,150° C. A fact which therefore commands the closest attention is the difference of approximately 200° between the lowest melting point of the silver solder group and the lowest melting point of the brazing brasses group, and the difference of 300° C. between the highest melting points of the two groups. The greater fusibility of the silver solders is not accompanied by any diminution of those important properties on which the value of a true solder depends and the use of silver solders is therefore especially recommended in all cases where the higher temperature required to melt brazing brasses tends to produce "grain growth."

The free flowing and penetrating qualities of silver solders greatly assist the production of strong, ductile joints. In the cast condition the tensile strength of silver solders varies from about 15 to 30 tons per sq. in., mainly depending upon the constitution of the alloy. The strength of the joint, however, is also dependable upon many variable factors, the effect of which can be accurately determined only by testing under actual working conditions, which procedure is recommended wherever possible. It is acknowledged that by using the correct grade of silver solder with proper brazing technique, the resultant joint can frequently be made equally strong as the metal to which the solder is applied. Joints made with "brazing brass" will not stand heavy stress, and the consequence of failure may be far reaching. Silver solders being more malleable and ductile, and having much higher tensile strength than "brazing brasses" will also make better joints, with greater resistance to shock and vibration. Used in conjunction with brass, bronze, copper, nickel and nickel alloys, such as monel metal, they have been subjected to laboratory tests in dilute solutions of sulphuric, hydrochloric and acetic acids, dilute ammonia and tenth normal salt solution. As a result of these tests it has been proved that silver solders are infinitely superior to brazing brasses in their resistance to corrosion, which is an important consideration when corrosion-resistant metals are employed.

Economical Use in Workshops

The physical properties of silver solders permit these alloys to be produced in the form most convenient for economical use in the workshop; there is no waste. Whether supplied in sheet, strip, wire or filings, it is necessary to use only the minimum quantity to secure maximum strength at the point of application. The silver employed is electrolytically refined, the base metals are the purest obtainable, and the melting is pyrometrically controlled.

The flux usually employed with silver solders is borax, which melts readily and is perfectly fluid at 760° C.; it may be used as a saturated solution in water, or made into a suitable paste by mixing with water or alcohol. Borax is eminently satisfactory for use with copper, brass, and the various bronzes. In engineering practice, however, a mixture of borax and boric acid is sometimes preferred for iron, steel, nickel and nickel alloys; the addition of boric acid tends to reduce the fluidity and "swelling up" of the borax at the higher temperature required for the jointing of these metals. Special fluxes are supplied for use with stainless steel and other alloys containing chromium; in these instances the refractory oxides formed during the soldering operation are not readily dissolved in ordinary borax, and it is therefore important to use the special mixtures recommended to ensure the proper "wetting" of the surface by the solder.

Silver solders find increasing application for making strong, ductile joints on brass of all compositions. In many cases silver solders have entirely superseded ordinary brazing alloys, especially where experience has shown that damage due to over-heating the metal can be avoided by using the correct grade of silver solder with a relatively low "flow point." Copper is second only to silver in heat conductivity, and although the relatively high melting point of copper permits the use of all grades of silver solder, it is desirable to use a high grade solder with a low flow point in order to prevent deterioration of the copper by over-heating. This precaution is doubly necessary when sections of thin tubing are involved. For this purpose a solder with a "flow point" of 670° C. is eminently satisfactory. High grade silver solders are also recommended to produce strong ductile joints on sheet, rod or tube, where subsequent cold work is introduced. In all cases due care must be exercised both in the choice of solder and the control of temperature during the soldering operation, to avoid local over-heating and consequent "grain growth."

Notable Corrosion-Resistance

These high class engineering alloys also have wide application for a variety of industrial purposes, and are largely used where durability, strength and corrosion-resistance are the main considerations. Silver solders are also used extensively in marine engineering. Turbine manufacture, where great strength and resistance to corrosion are vital factors, is dependent upon them for fixing the blades in position. Increasing instances of their application are found in the manufacture of dyeing and bleaching machinery, hospital fittings and other equipment where monel metal is employed.

To ensure perfect joints due care must be exercised to prevent oxidation of the metal during the soldering operation. The successful jointing of cupro-nickel and nickel alloys of the monel metal type depends on the careful control of the temperatures during the brazing operation. These alloys should not be heated above 790° C. since higher temperatures tend to produce a coarse structure in the metal with consequent poor working properties. Where applicable, high grade silver solders are especially finding favour for the various stainless steel alloys, the necessary control of temperature being more readily effected by use of these jointing materials, than by the use of ordinary brazing brass. It is also recognised that the successful soldering of stainless steels (containing chromium in varying proportions) depends to a great extent on the adequate protection of the surface during the soldering operation. Careful regulation of the temperature, which must be maintained as low as possible, is necessary to prevent the formation of a refractory oxide, which prevents the proper adhesion of the solder.

Zinc Production in Canada

Preliminary figures issued by the Dominion Bureau of Statistics at Ottawa show that the production of zinc in Canada during 1932 totalled 172,283,558 lb., valued at $4,144,454. British Columbia is by far Canada's principal zinc producing province and the Sullivan mine the principal source. Manitoba has come to the front as a zinc producer during the past two years since the construction by the Hudson Bay Mining and Smelting Co., Ltd., at Flin Flon, Manitoba, of a zinc refinery in conjunction with their copper smelter.

Some Recent Metallurgical Patents

Refining Metals and Alloys

MAGNESIUM or magnesium alloys, according to Specification No. 375,743 of F. Badger and British Maxium, Ltd., are refined by heating to a temperature not exceeding 800° C. with a flux consisting of magnesium fluoride and hydrous magnesium chloride, for example a flux consisting of 40 per cent. magnesium fluoride and 60 per cent. magnesium chloride containing 2.20 per cent. by weight of water. The flux rises and forms a solid crust over the surface of the metal which may be run into casting moulds from a point below the level of the crust, the space so formed between the molten metal and crust being preferably filled with inert vapour.

Aluminium Alloys

A CORROSION resistant aluminium alloy may contain lead, sodium, and titanium in such proportions that the titanium is maintained in solution by the lead in both solid and molten states. Manganese may also be present. The alloy, according to Specification No. 387,562 of A. Strasser and W. Germann, may be made by adding to aluminium 0.5-5.8 per cent. of titanium, 0.5 per cent. of manganese, and 1-6 per cent. of an all of 98-98.5 per cent. of lead and 1.5-2 per cent. of sodium; or an intermediate alloy of lead, titanium, and sodium may be used. In some cases titanium may be replaced by an equivalent amount of titanium oxide which is reduced by the aluminium.

Cleaning Metals

IRON or steel or articles with an iron or steel surface can be pickled in an aqueous solution of hydrogen peroxide and either nitric acid, hydrochloric acid, or a mixture of nitric acid, and another pickling acid, *e.g.*, a mixture of nitric and sulphuric acids or of nitric and phosphoric acids. The temperature of the solution, according to Specification No. 375,599 of M. Coslett anrd T. W. Coslett, is kept at or below about 60° F. and the hydrogen peroxide acts as an inhibiting agent. The solutions are particularly applicable to the pickling of high-carbon steels, chromium-containing rustless steels, and highly polished steels to give a surface suitable for painting, enamelling, sherardizing, or a phosphating rust-proofing treatment.

Distilling Zinc

A CONTINUOUS distillation process for the production of zinc or similar volatizable metals in a rotary furnace, is described in Specification No. 374,900 of F. Krupp Grusonwerk, A.G. The process comprises the reduction and volatilisation of the metal from the mixture of material and reducing substance in a muffle which is built into a rotary furnace, the residue from the muffle process being discharged, whilst excluding gas therefrom as far as possible, into the furnace space of the rotary furnace, and the reducing material still present in the residue being burnt in the furnace space with the addition of fases containing oxygen, so that the heat of combustion is utilised to heat the muffle. Metal vapours from the muffle pass to a condenser, residual gases from which can be used for the heating of the muffle.

Improving Iron Alloys

IN a process for improving the properties of iron or steel either unalloyed or alloyed but containing at least 50 per cent. of iron, described in Specification No. 374,541, of F. Krupp, A.G., one or more of the elements, tantalum mobium, cerium, and uranium are included in the iron, etc., in a total amount of 0.1 to 8 per cent. and the alloy so constituted is cooled quickly or slowly from the casting temperature or in the case of reheating the alloy, from 700° to 1,300° C. and then tempered at 150° to 800° C. When the alloy has been reheated, the alloy may be subjected to a particularly slow cooling instead of tempering. The alloy may also contain one or more of the elements silicon, manganese, nickel, chromium, tungsten, molybdenum, vanadium, and cobalt. The process is particularly applicable to stainless chromium or nickel-chromium iron or steel alloys.

Coating with Metals

A METAL such as molybdenum, tungsten, or nickel can be treated with a solution of an azide of an emissive metal the temperature of which is above 50° C. and then dried, according to Specification No. 388,586, of Egyesült Izzólámpa és Villa Mossagi Részvény-Társaság. The coated metal may then be heated to decompose the azide to get a metallic coating, for example in the preparation of a cold or incandescent cathode having a metallic or metallic oxide emissive layer. The azide solution is preferably saturated and at boiling-point and the base metal is preferably preheated to a temperature above the boiling-point of the solution and may be immersed in or sprayed or painted with the hot solution.

Hardening Iron Alloy Articles

IN the manufacture of hardened iron or steel alloy articles, according to Specification No. 386,665, of F. Krupp Akt.-Ges., the article is roughly fabricated from alloys containing a nitrogenising element such as aluminium, chromium, molybdenum or manganese and a precipitation-hardening element such as copper, beryllium, boron or titanium is cooled from a temperature lying between the nitrogenising temperature and 1,300° C. in water, oil or air, is fabricated or worked to its final shape and then subjected to the usual nitrogenisation process which also produces precipitation-hardening. The articles may be tempered at a temperature below the critical temperature but above the nitrogenising temperature before it is fabricated or worked.

Nitrogenising Iron

IN a process of nitrogenising iron, steel, and alloys thereof, described in Specification No. 374,096, of the Electro Metallurgical Co., nitrogenisation is effected by a gaseous nitrogenising agent to which has been added an organic compound containing nitrogen. Aliphatic aromatic and heterocyclic compounds may be used such as carbocyclic compounds containing one or more nitro-radicals, *e.g.*, nitrobenzene and mono-nitro-toluene, amino compounds, *e.g.*, aniline phenylene-diamine and alpha-naphthylamine, and heterocyclic compounds containing nitrogen in the ring, *e.g.*, pyridine and quinoline. The gaseous nitrogenising agent may be passed through the organic nitrogen compound which is heated to a temperature just below its boiling point. In an example an alloy containing 95.5 per cent. of iron, 1 per cent of aluminium, 1.7 per cent. of chromium, 0.1 per cent. of molybdenum, 0.3 per cent. of carbon, 0.5 per cent. of manganese, 0.3 per cent. of silicon, and the remainder phosphorus sulphur, etc., was placed in a closed container and ammonia which was bubbled through nitrobenzene was then passed through the container, the container being heated to 460° C for four hours.

Foundrymen's Conference at Cardiff

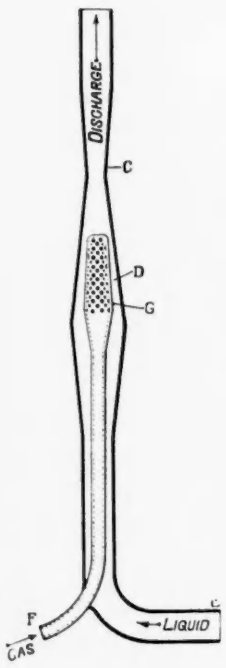
THE annual conference of the Institute of British Foundrymen will be held at Cardiff, June 20-23. Papers to be presented at the technical sessions held in conjunction with this meeting will include:—"Modernised Foundries," by F. J. Cook; "Routine Methods of Testing Green Sands," by the Sands Sub-Committee of the Technical Committee; "Alloy Grey Irons," by Dr. Ing. C. W. Pfannenschmidt; "Heat-resisting Cast Irons," by E. Morgan; "Alloy Cast Iron," by Frank Coyle; "The Anodic Treatment and Dyeing of Aluminium Castings," by N. D. Pullen; "Coke Practice in the South Wales District," by W. R. D. Jones.

Birmingham Metallurgical Society

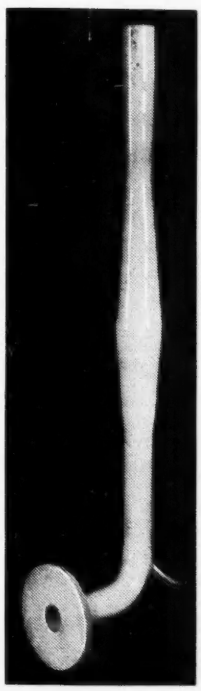
MR. W. A. BENTON was elected president at the twenty-eighth annual meeting of the Birmingham Metallurgical Society, held on May 30. The following were elected vice-presidents: Messrs. H. Davies (senior), J. Fallon, N. P. Allen and E. A. Bolton; honorary treasurer, Mr. A. C. Craig; auditors, Messrs. Poppleton and Appleby; five members of the council, Messrs. H. J. Miller, C. H. H. Franklin, T. W. Ellett, P. A. Tucker and E. Pagett. It was stated in the annual report that the influx of new members had been maintained. The society's bronze medal and prize was awarded to Mr. R. J. Brown for his thesis on "The Microscope in Automobile Engine Production."

VITREOSIL

AIR-LIFT PUMP



This pump is so designed that the air stream is finely divided, thus avoiding a "pistoning" effect and ensuring high efficiency. Being made throughout of VITREOSIL, it is absolutely unaffected by acids or extreme changes of temperature, thus ensuring a long and trouble-free life. It can be made of any required size according to the quantity of liquid with which it has to deal.



We shall be glad to quote for a pump to deal with any special case if you will send us particulars of the height of lift, specific gravity and volume of liquid to be handled.

THE THERMAL SYNDICATE LTD.

WALLSEND-ON-TYNE

Established over quarter of a century

London depot: - - - Thermal House, Old Pye Street, S.W.1

INDEX TO ADVERTISERS

Ordinary numerals before names of firms show page numbers of advertisements in "The Chemical Age Year Book" for 1933

Aluminium Plant and Vessel Co. Ltd. — v
Appleton & Howard, Ltd. —
Armco International Corporation —
Ashworth, Oliver & Co. — xiii
Association of British Chemical Manufacturers —

Bakelite, Ltd. —
76-77 Barter Trading Corporation, Ltd. —
Battersea Polytechnic —
Belgian National Railways —
56 Bellamy, John, Ltd. —
Bell Brothers (Manchester 1927), Ltd. —
Benjamin Electric, Ltd. —
Benn Bros., Ltd. —
50 Benn, Ernest, Ltd. —
74 Bennett & Jenner, Ltd. — 586
B.E.N. Patents, Ltd. —
Berk (F. W.), & Co., Ltd. — 586
Best (Jas.), & Sons —
Binney & Smith & Ashby, Ltd. —
53 Birmingham Battery & Metal Co. Ltd. —
Bolton (Thos.) & Sons, Ltd. —
Booth (J.), & Sons, Ltd. —
89 Boots Pure Drug Co., Ltd. —
80 Bowman's (Warrington), Ltd. — 586
Braby, F., & Co., Ltd. —
Breaks Bros. —
Bristol's Instrument Co., Ltd. —
75 British Association of Chemists — 586
British Burckhardt Compressors, Ltd. —
British Carbo Union, Ltd. —
British Commercial Gas Association, The —
81 British Drug Houses, Ltd. —
British Hanovia Quartz Lamp Co. Ltd. —
British Hydrological Corporation —
83 British Industrial Solvents, Ltd. Front Cover
British Industries Fair —
Brothers Chemical Co. (1929), Ltd. — 586
Brotherton & Co., Ltd. —
29 Brough (E. A.), & Co. —
Brown & Forth, Ltd. —
Brown & Son (Alembic Works, Ltd.) —

Cafferata & Co., Ltd. —
Calorizing Corpn. (G. B.), Ltd. —
Cambridge University Press —
Campbell, Rex & Co., Ltd. —
Carter (J. Harrison), Ltd. —
58 Carty & Sons, Ltd. — xiii
Chemical & Metallurgical Corporation, Ltd. —
84 Chemical Engineering & Wilton's Patent Furnace Co., Ltd. —
Chemical Supply Co., Ltd. —
The Chemical Society — vi
54 Chesterfield Tube Co., Ltd. —
28 Christy & Norris, Ltd. —
Clifford (Chas.) & Sons, Ltd. —
Cortin & Corking, Ltd. — iii
Crone & Taylor, Ltd. —

44-45 Dale (John) Mfg. Co. — iii
90 Dalheim, T. G. —
52 Delaville Spelter Co., Ltd. —
39 Dexine, Ltd. —
Dickinson, John (Bolton), Ltd. —
32-33 Dorr-Oliver Company, Ltd. —
Doulton & Co., Ltd. —
Third Cover Duxbury (Thomas), & Co. —

Edwards, W., & Co. —
Enamelled Metal Products Corporation, Ltd. —
64 Evans, Adlard & Co., Ltd. —
Evans, T. E. & Co., Ltd. —

52 Feltham, W. H. & Son — Cover iii
24-25 Follows & Bate, Ltd. —
Foster Instrument Co. —
Foster Jos., & Sons, Ltd. —
27 Four Oaks Spraying Machine Co. —
Foyle (W. & G.) —
Fraser (W. J.) & Co., Ltd. —
88 Fullerslte —

Gallenkamp, A. & Co., Ltd. —
Gardner, Wm., & Sons (Gloucester), Ltd. —
Gas Light & Coke Co., The — x
66 General Chemical & Pharmaceutical Co., Ltd. (The) —
G.K.S. Combustion Co., Ltd. —
Glycerine, Ltd. — 586
Griffiths Bros. & Co. (London), Ltd. —
Guelph Patent Cask Co., Ltd. —
G. V. D. Illuminators — vi

48 Harris (P. L. & G. S.), Ltd. — Cover iii
Hathern Station Brick & Terra Cotta Co., Ltd. —
Haughton's Patent Metallic Packing Co., Ltd. — xiv
80 Heim, S., Ltd. —
65 Hill-Jones (Thos.), Ltd. — x
Hopkin & Williams, Ltd. — xiv
Horne Engineering Co., Ltd. — Cover ii
Howards & Sons, Ltd. —
51 Hurrell (G. C.), & Co., Ltd. — vi

Imperial Chemical Industries, Ltd. — ix
Incandescent Heat Co., Ltd., The — vii
Institute of Chemistry —
48 International Electrolytic Plant Co. (The) —
International Pulverisers, Ltd. —

62 Jahn, F., & Co. —
Jenkins Bros., Ltd. —
46 Jenkins, R., & Co., Ltd. —
72-73 Johnson, Matthey & Co., Ltd. —
Jones & Co. (Methylators), Ltd. —

Kelvin, Bottomley & Baird, Ltd. — viii
Kestner Evaporator & Engineering Co., Ltd. — vii
Key Engineering Co., Ltd. —
Kilner (John) & Sons (1927), Ltd. —
Kola-Nuts Planters' Association —
K.S.B. Manufacturing Co., Ltd. —

Lancaster & Tonge, Ltd. — iv
74 Laporte, B., Ltd. —
Leeds & Bradford Boiler Co., Ltd. —
Legrand, Sutcliff & Gell, Ltd. —
58 Leigh (R. & H.), Ltd. — xiv
84 Leitch (J. W.), & Co., Ltd. —
49 Lennox Foundry Co., Ltd. —
Lever Bros., Ltd. — 586
Limmer & Trinidad Lake Asphalt Co., Ltd. — xiii
30 Lord (John L.) —

66 Manchester College of Technology — viii
Manlove, Alliott & Co., Ltd. —
26 Meldrums, Ltd. —
94 Methylating Co., Ltd. —
Millbank Engineers, Ltd. —
Mills-Packard Construction Co., Ltd. —
Mining & Industrial Equipment, Ltd. —
Miracle Mills, Ltd. —
41 Mitchell (L. A.), Ltd. — 586
68-9 Monsanto Chemical Works, Ltd. —

Negretti & Zambra —
Nordac, Ltd. —
Nor-Rust Liquid Lead Co., Ltd. —

61 Oertling (L.), Ltd. —
82 Ohlenschlager Bros., Ltd. —
Oxley Engineering Co., Ltd. —

70-71 Page (Chas.) & Co., Ltd. —
35 Paterson Engineering Co., Ltd. —
Perry & Hope, Ltd. —
Piggott (Thos.) & Co., Ltd. —
Piras, Ltd. —
Pitman (Sir Isaac) & Sons, Ltd. —
60 Potter (F. W.), & Soar, Ltd. —
Premier Filterpress Co., Ltd. — xiv
67-78 Price, Stutfield & Co., Ltd. —

56 Reads, Ltd. —
Redler Patents —
88 Richards, A. H. —
54 Robinson (F.), & Co., Ltd. —
86 Ronsheim & Moore, Ltd. —
36 Rowlandson (W.), & Co. — vii

Scientific Glass Blowing Co. — 586
Scott (G.), & Sons (London), Ltd. —
90 Shawinigan, Ltd. —
49 Siebe, Gorman & Co., Ltd. —
95 Silica Gel., Ltd. —
93 Sofnol, Ltd. — v
82 Spence, Peter & Sons, Ltd. —
87 Spencer Chapman and Messel, Ltd. — 586
Staveley Coal & Iron Co., Ltd. —
Facing cover third Steam Engineer (The) —
Steward, J. H., Ltd. —
Stewarts and Lloyds, Ltd. —
Super Centrifugal Engineers, Ltd. —
Sutcliff Bros. & Bryce, Ltd. —

85 Tennant, C., & Co., Ltd. — Cover iii
63 Thermal Syndicate, Ltd. — i
Thomas, W. K. & Co. —
Thompson Bros. (Bilston), Ltd. —
57 Thom, John, Ltd. — iii
42 Todd Bros. — xiv
Facing cover third Troup (John D.), Ltd. —
Trussed Concrete Steel Co., Ltd. —
92 Tyrer (Thos.), & Co., Ltd. —

University Press of Liverpool —
University of Liverpool —

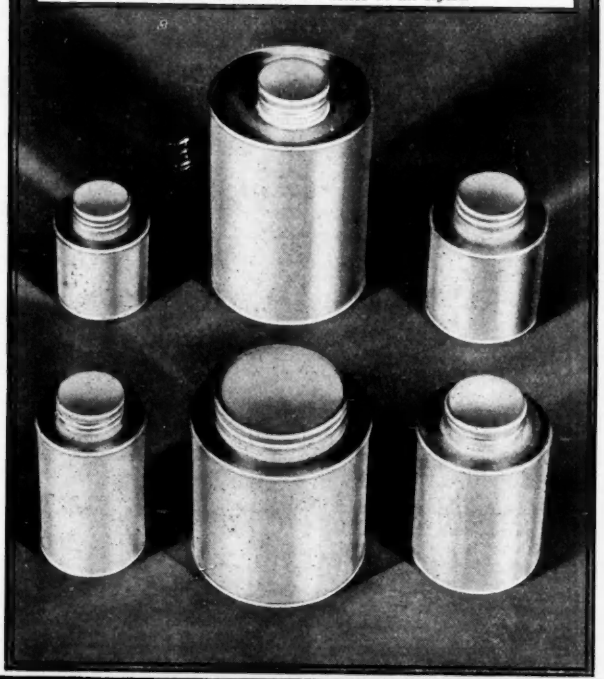
91 Viaduct Alum Co., Ltd. —
50 & 63 Valor Co., Ltd. —
Venton (H. W.), Ltd. —
Vokes, C. G., Ltd. —

Walker Crosweller & Co., Ltd. —
Walker, Jas., & Co., Ltd. —
40 Wallach Bros., Ltd. — Cover iii
59 Waller, Geo. & Son, Ltd. — vi
38 Webb (W. A.), Ltd. — Cover ii
Weinreb, F. —
Wenborn's Scientific Supplies —
Wengers, Ltd. — xiv
Western Chemical Co. (Paisley), Ltd. — iv
West's Gas Improvement Co., Ltd. —
46 Whitaker, B., & Sons, Ltd. — Cover ii
Wilkinson, Jas. & Son, Ltd. —
Windschuegl, Chas. H. —
64 Windsor, H., & Co., Ltd. — Cover iv
38 Woolley (Jas.), Sons & Co., Ltd. —
Worthington Simpson, Ltd. —

Agencies —
Appointments Wanted — 586
Appointments Vacant —
Articles for Sale or Wanted — xiii
Business Offer — xiii
Business for Sale —
Companies' Notices —
Contracts —
Educational —
Financial —
Official Notice —
Patents for Development — xiii
Public Notice —
Sales by Auction —
Stocks and Shares —
Miscellaneous —

Comprehensive Buyers' Guide Sections appear in "The Chemical Age Year Book," a copy of which is sent free in December to every yearly subscriber to "The Chemical Age"

Canisters for all Purposes, Plain or Decorated, manufactured by
THE JOHN DALE MFG COY NEW SOUTHGATE, LONDON, N.11.
also aluminium and tin boxes in all styles.



CORTIN & CORKING LTD
Chemical Plant Manufacturers
ST. LAWRENCE ROAD, NEWCASTLE-UPON-TYNE
TELE { PHONE : 551 CENTRAL / GRAMS : CORTIN, NEWCASTLE-UPON-TYNE

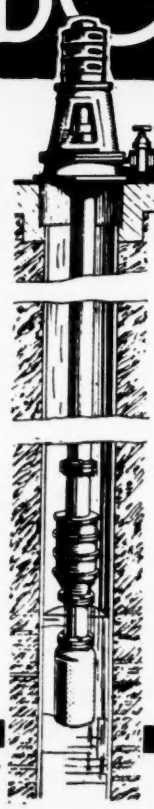
Acid Valves, Taps, Pumps, &c., for the Chemical and Allied Trades.

ALSO COMPLETE LEAD BURNING APPARATUS

No. 42. Straight Through Non-Return Acid Valve.

BORE HOLES to any depth

FOR CHEAP WATER



Our World-wide experience is at your service. Let us help you.

'Phone : 3069 ECCLES.
Grams : "THOM, PATRICROFT."

Also for :—
BRINE—COAL—MINERALS
Proving Strata for Foundations, etc.

ARTESIAN WELLS
PUMPING PLANT
ROTARY & RECIPROCATING

Steam or Electric Drive
AIR LIFTS, ETC.

WATER SUPPLIES
JOHN THOM LTD
CANAL WORKS PATRICROFT ENGLAND

The
LANCASTER
STEAM TRAPS

The most economical trap made. Will drain water at from 212° Fahr. upwards from any pressure of steam. Can be examined while working. The users of over 140,000 of the "LANCASTER" Steam Traps testify to their efficiency.

LANCASTER & TONGE LTD.
Pendleton **Manchester**
Telephone: PENDLETON 1484 (2 lines) Telegrams: "PISTONS," Manchester

CARBONATE AMMONIA

THISTLE BRAND

LUMP	PHARMACY
POWDER	BAKING
(free running)	INDUSTRIAL

SOLE MAKERS:
THE WESTERN CHEMICAL CO.
(PAISLEY) LTD.
SANDYFORD WORKS PAISLEY

CHEMICAL AND INDUSTRIAL ENGINEERING

Art and Principles of Chemistry	Armstrong	15 0
Bituminous Substances	Spielmann	15 0
Cellulose Acetate	Lipscomb	21 0
"Chemical Age" Dictionary of Chemical Terms		16 0
Chemistry, Manufacture and Application of Artificial Fertilisers. Vol. I	Ogilvie	45 0
Chemistry of Chemotherapy	Dyson	32 6
Chemistry of Drugs. 2nd Ed.	Evers	55 0
Chemistry of Essential Oils	Finnemore	70 0
Condensed Outline of Modern Physical Chemistry	Constable	10 6
Drying by Means of Air and Steam	Hausbrand	6 0
Dye Chemistry	Georgievics	15 0
Evaporating, Condensing and Cooling Apparatus	Hausbrand and Heastie	25 0
Fats: Natural and Synthetic	Myddleton	10 0
Filtration and Filters	Pickard	45 0
Foundations of Colloid Chemistry	Hatschek	7 6
Industrial Applications of Coal Tar Products	Bunbury	19 6
Industrial Catalysis	Green	50 0
Industrial Uses of Bauxite	Knibbs	21 0
Intermediates for Dyestuffs	Davidson	17 6
Limestone and its Products	Searle (*in preparation*)	
Making of a Chemical	Lewis and King	12 6
Manufacture of Sulphate of Ammonia and Crude Ammonia	Calvert	3 6
Modern Printing Inks	Seymour	6 0
Paper Mill Chemist	Stevens	10 6
Recent Progress in Rubber Chemistry and Technology	Schidrowitz	3 6
Recovery and Use of Industrial Wastes	Kershaw	25 0
Specific Heats of Gases	Partington	30 0
Synthesis of Benzene Derivatives	Bate	9 6
Synthesis of Nitrogen Ring Compounds	Hollins	55 0
Synthetic Rubber	Schotz	21 0
Utilization of Wood Waste	Hubbard	5 0
Wood Products. In 2 Parts	Dumesny and Noyer	7 6

Part I.—Chemical Products of Wood Distillation.
Part II.—Dyeing and Tanning Extracts from Wood.

CHEMICAL ENGINEERING MONOGRAPHS

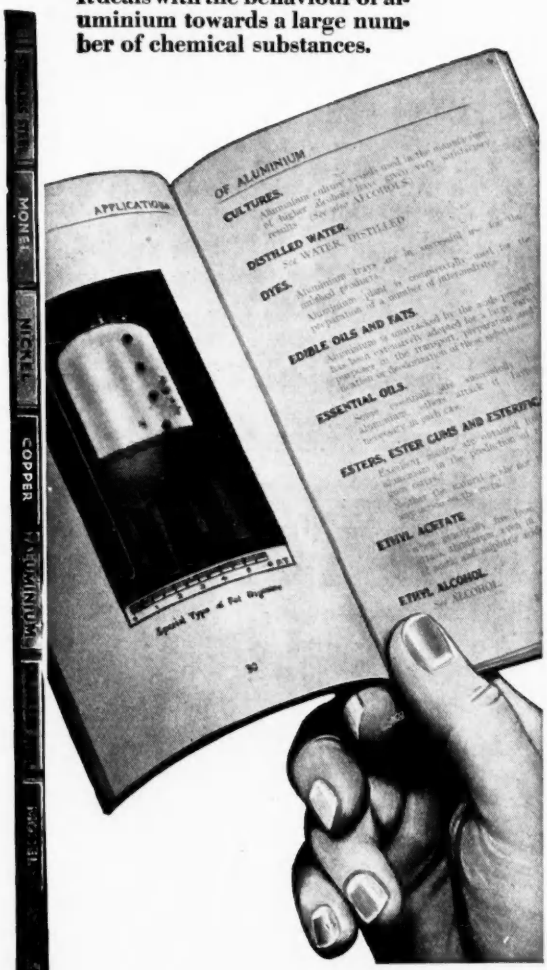
Agitating, Stirring and Kneading Machinery	Seymour	2 6
Autoclaves and High Pressure Work	Goodwin	2 6
Centrifugal Dryers and Separators	Alliott	2 6
Design and Arrangement of Chemical Plant	Weyman	2 6
Distillation in Practice	Elliott	2 6
Dust Hazard in Industry	E. Gibbs	2 6
Mechanical Draught	Lister	2 6
Mechanical Mixing Machinery	Carpenter	2 6
Organization of Production	Curtis	2 6
Sulphuric Acid Concentration. 2 Vols.	Parrish, *each*	2 6
Sulphuric Acid Reaction Chambers	Parrish	2 6
Theory and Practice of Combustion	Lister	2 6
Transport and Handling of Mineral Acids	Hirsch	2 6

Full details of any book sent on request.

ERNEST BENN LIMITED, Bouverie House, Fleet Street, London, E.C.4

HERE'S A BOOK WORTH HAVING & KEEPING

This booklet entitled "Aluminium as applied to the Chemical Industries" will be sent post free to any bona-fide trade enquirer. It deals with the behaviour of aluminium towards a large number of chemical substances.



APV

ENGINEERING PLANT AND VESSEL CO. LTD.

POINT PLEASANT · WANDSWORTH

A word on Water Treatment

IF you use a lime-soda water softening plant, you can get better results this way. Abolish the laborious and uncertain process of separately added lime and soda. Make one addition only—of SOFNOL MIXTURE. This will be manufactured by us to the individual analysis of your water supply. Some of the largest power stations and industrial plants in the country have used our system for years. SOFNOL MIXTURE saves labour, and being always chemically exact, it ensures maintained correctness of treatment—preventing scale and corrosion. May we have a sample of your feed water for free analysis, and quote you?

SOFNOL

SOFNOL Ltd. WESTCOMBE HILL GREENWICH S.E.10

"Talk it over with Sofnol"

Sofnol Ltd. Westcombe Hill, Greenwich, S.E.10

TAS/Si.18

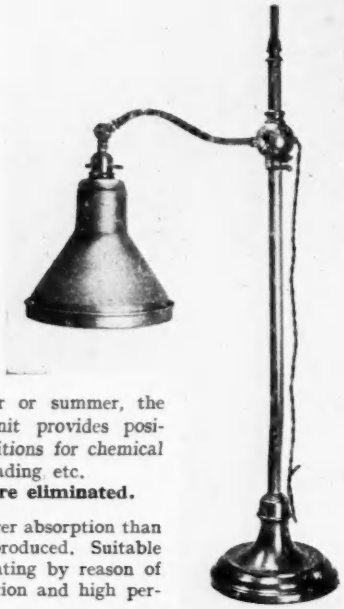
FOR

GREATER ACCURACY

in the Laboratory

DAYLIGHT

at the touch of a switch—



DAY or night, winter or summer, the G.V.D. Daylight Unit provides positively standardised conditions for chemical tests, colour matching, grading etc.
Errors and eyestrain are eliminated.

Greater accuracy and lower absorption than in any other light yet produced. Suitable for general industrial lighting by reason of its low current consumption and high percentage of illumination.

★ *Please call for a demonstration or ask for catalogue giving full information, spectral curve, etc.*

G. V. D. ILLUMINATORS (G. V. Downer)
ALDWYCH HOUSE, ALDWYCH, LONDON, W.C.2
Phone : Holborn 8879.

Ready Shortly

VOLUME III
of the
MEMORIAL LECTURES
delivered before
THE CHEMICAL SOCIETY
1914-1932

The Emil Fischer Memorial Lecture. By Sir M. O. Forster, F.R.S. (Delivered on October 28th, 1920.)

The Baeyer Memorial Lecture. By W. H. Perkin, F.R.S. (Delivered on May 10th, 1923.)

The Van der Waals Memorial Lecture. By Sir J. H. Jeans, F.R.S. (Delivered on November 8th, 1923.)

The Kamerlingh Onnes Memorial Lecture. By Ernst Cohen, For.Mem.R.S. (Delivered on February 10th, 1927.)

The Arrhenius Memorial Lecture. By Sir James Walker, F.R.S. (Delivered on May 10th, 1928.)

The Theodore William Richards Memorial Lecture. By Sir Harold Hartley, C.B.E., F.R.S. (Delivered on April 25th, 1929.)

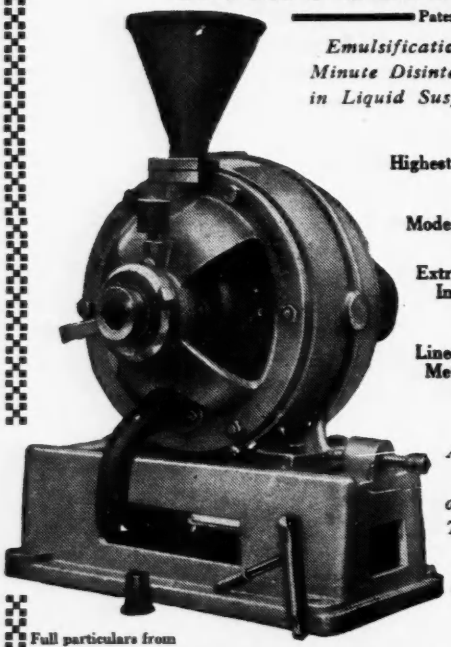
The Otto Wallach Memorial Lecture. By Leopold Ruzicka. (Delivered on March 10th, 1932.)

PRICE 6/-
(Postage extra)

THE CHEMICAL SOCIETY
Burlington House, Piccadilly, London, W.1

THE HURRELL HOMOGENISER

Patent 214306



Emulsifications and Minute Disintegrations in Liquid Suspensions.

◆

Highest Efficiency.

◆

Moderate Cost.

◆

Extreme Ease of Installation.

◆

Lined with Monel Metal or other alloys.

◆

Automatic Control of Rate of Treatment.

Self Cleaning.

◆

Full particulars from

G. C. HURRELL & CO., Ltd. Phone : Greenwich 1116
Old School Works, Woolwich Rd., Charlton, S.E.7

ROTARY BLOWERS & EXHAUSTERS

•

Suitable for Activating, Exhausting, Blowing
(up to 5 lbs. per sq. in.)
Belt, Steam or Electric Drive

•

GAS COMPRESSORS
Vertical—Horizontal—Crankless

•

GAS VALVES
of all types and sizes, single and double faced

•

PUMPS
for Tar, Benzol, Water, etc.

•

Write for Catalogues

•

George Waller & Son Ltd.
Phoenix Ironworks, Stroud, Glos.

MIXING PANS
FOR ALL PURPOSES

Sizes:
9 inches to 6 feet diameter.

Made with Steam Jackets and Tipping Gear

Any design of stirrers or mounting to suit special materials or position.

Suitable for liquids or powders.

As used by the leading manufacturers throughout the country.

Write for particulars to: –

W. ROWLANDSON & CO.
75N MARK LANE, LONDON, E.C.3.

ACID RESISTING VITREOUS ENAMELS

Acid-resisting Vitreous Enamels resistant to hydrochloric, sulphuric, nitric, citric, lactic and many other commercial acids and food compounds.

■

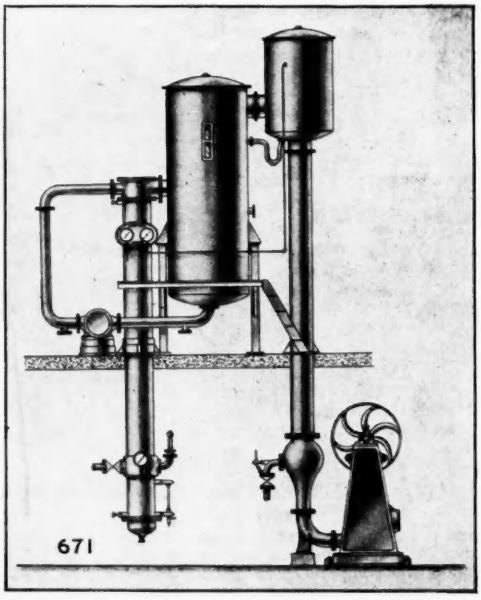
Complete Vitreous Enamelling Plants for every purpose.

■

INCANDESCENT HEAT C^{O}. L^{TD}.
Cornwall Road, Smethwick,
BIRMINGHAM.

'Phone:- 0875-0876-0877 Smethwick.
'Grams:- Repeat Birmingham.

KESTNER (PATENT) FORCED CIRCULATION
EVAPORATORS
in large or small units



EVAPORATORS for salting liquors.

EVAPORATORS specially constructed for acid liquors.

HORIZONTAL Evaporators for small quantities

SUBMERGED Flame Evaporators.

Kestner Evaporator and Engineering Co., Ltd., CHEMICAL ENGINEERS, 5 Grosvenor Gardens, Westminster, LONDON, S.W.1.

MANCHESTER MUNICIPAL COLLEGE OF TECHNOLOGY.

Principal: B. MOUAT JONES, D.S.O., M.A. (Oxford).

UNIVERSITY OF MANCHESTER
(FACULTY OF TECHNOLOGY).

DEGREE COURSES in TECHNOLOGY

The Prospectus gives particulars of the courses leading to the Manchester University Degrees (B.Sc.TECH., M.Sc.TECH., and PH.D.) and Certificates in the Faculty of Technology, in the following departments:—

APPLIED CHEMISTRY, including General Chemical Technology, Metallurgy and Assaying, Fermentation Processes (including Brewing), Electro-Chemistry, Photography, Colouring Matters, Foodstuffs and Fuels. (Professor James Kenner, D.Sc., PH.D., F.R.S.)

TEXTILE CHEMISTRY (Bleaching, Dyeing, Printing and Finishing), Paper Manufacture. (F. Scholefield, M.Sc., F.I.C., F.T.I.)

MECHANICAL ENGINEERING. (Professor Dempster Smith, M.B.E., M.Sc.TECH., M.I.M.E.)

ELECTRICAL ENGINEERING. (Professor John Hollingworth, M.A., D.Sc., A.C.G.I., M.I.E.E.)

MUNICIPAL ENGINEERING. (G. S. Coleman, D.Sc.ENG., A.M.INST.C.E., A.M.INST.M. & CY.E., F.R.SAN.I.)

TEXTILE TECHNOLOGY. (Professor W. E. Morton, M.Sc.TECH., F.T.I.)

BUILDING. (W. B. McKay, M.Sc.TECH., M.I.STRUCT.E., M.R.SAN.I.)

INDUSTRIAL ADMINISTRATION (Post-Graduate Certificate Course). (K. G. Fenelon, M.A., PH.D.)

Prospectus will be forwarded free on application to the Registrar, College of Technology, Manchester.

K·B·B
Ultra-Violet Fluorescence Testing Cabinet

Chemist's Quartz Lamp Cabinet

Provides method of rapid examination of Foodstuffs, Oils, and materials generally.

Detects bacterial action, presence of impurities, adulterants and substitutes, and differentiates between natural and synthetic materials.

The Late Lord Kelvin
Chairman 1900-1907

Kelvin, Bottomley & Baird, Ltd
18 CAMBRIDGE STREET,
GLASGOW.

London: Imperial House, Regent Street, W.1
'Phone No. Gerrard 7327. (*Entrance: Air Street.*)

BENN'S NEW TECHNICAL BOOKS

CELLULOSE ACETATE. Its Manufacture and Applications. *By A. G. Lipscomb, B.Sc. (Lond.), F.I.C.*

This work is intended to give a clear exposition of manufacturing processes, and to describe the lay-out of plant for the manufacture of cellulose acetate and of acetate rayon, including dyeing, printing and finishing of fabrics. Other uses of cellulose acetate, as in the manufacture of films and plastics, have received attention

Demy 8 vo. 308 pages, fully illustrated. Net 21s.

GENERAL PROPERTIES OF MATTER. *By F. H. Newman, D.Sc. (London), A.R.C.S., F.Inst.P. Professor of Physics in the University College of the South-West of England, Exeter and V. H. L. Searle, M.Sc. (Lond.).*

Now the standard work, particularly for students reading for the final and higher degree examinations, on the basic properties of matter. The physicist, chemist, mathematician and engineer will each and all find this important treatise on the quantitative principles of physical science of great value.

Demy 8 vo. 388 pages. Second Edition Revised and reduced in price to Net 18s.

NATURAL VARNISH RESINS. *By T. Hedley Barry.* The only account in the English language covering the history, botany, chemistry, physics and technology of the Natural Resins used in the Varnish Industry.

Royal 8 vo. 300 pages, 84 illustrations. Net 42s.

INTERNATIONAL HANDBOOK of the BY-PRODUCT COKING INDUSTRY. *By Dr. W. Gluud, Director of the Society for Coal Technology, Dortmund-Eving. English Edition by E. M. Myers.* 879 *pages, 413 illustrations. Net 84s.*

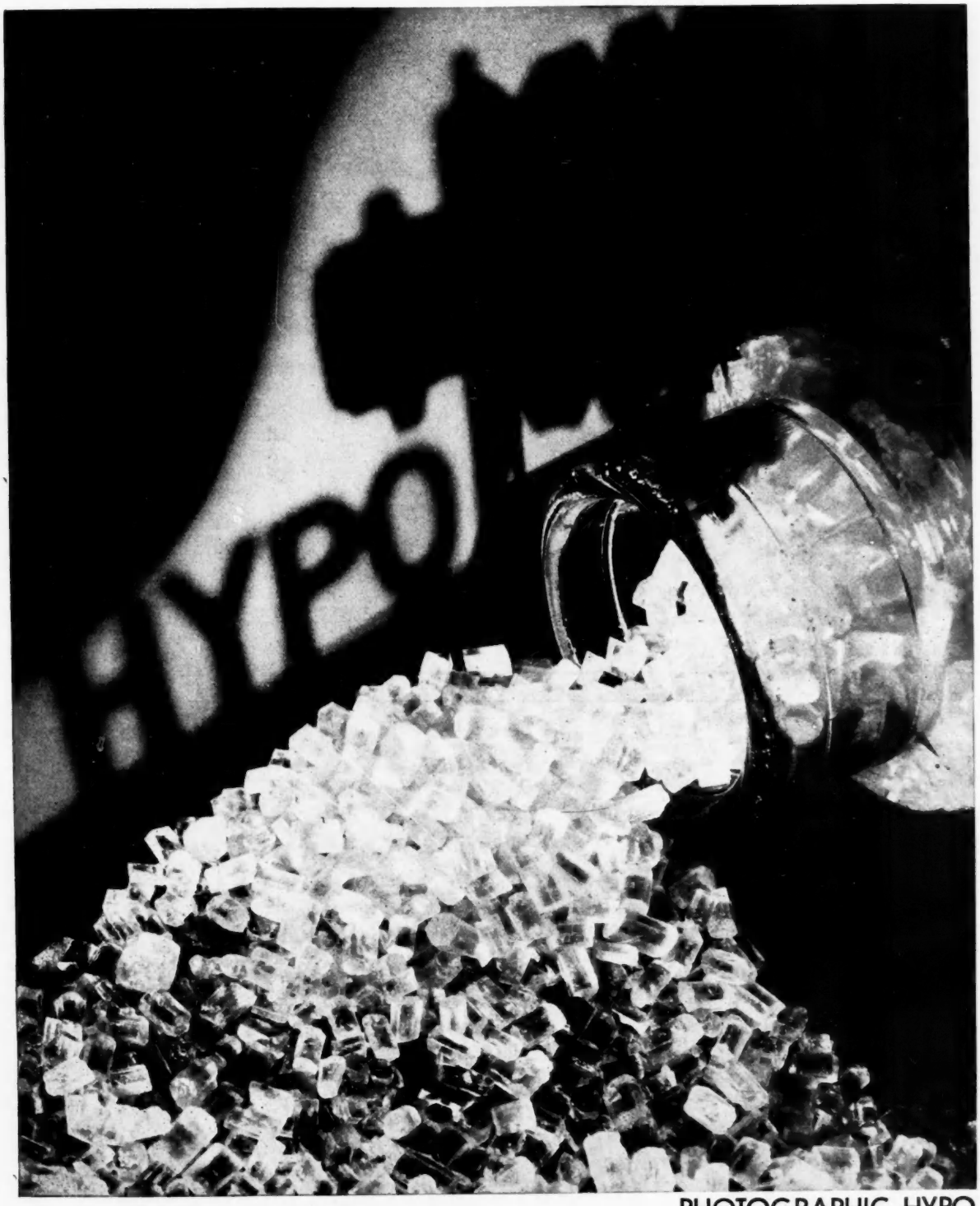
Dr. Gluud's monumental work supplies the long-felt need for a comprehensive treatise on the coking industry in all its post-war developments. He and his fellow-authors are in close touch with the mining and chemical trades of the Rhineland and the Ruhr, and are actively engaged in fuel research. They discuss both the theoretical and the practical sides of their subject, and they have received invaluable help from a number of leading German firms. The work is elaborately illustrated with photographs, plans and diagrams, and will at once become indispensable to all concerned with the full utilisation of coal and coke.

GAS CALORIMETRY. *By Major C. G. Hyde, M.C., A.R.C.S., F.I.C., Chief Technical Assistant to the Gas Referees and F. E. Mills, B.Sc., A.M.I.Chem.E. Chemist to the Gas Light and Coke Company Westminster Laboratory, with introduction by Professor C. V. Boys, A.R.S.M., F.Imp.Coll., LL.D., F.R.S.*

Now that gas is sold by its heating value as measured in therms and not as before in volume measured by cubic feet, the subject of calorimetry has assumed a far greater importance than ever before in the gas industry. The authors have therefore felt that the time has come for the production of a comprehensive treatise on the whole subject from the practical standpoint of the gas engineer, chemist, and manager. Their book describes the many types of calorimeter and their uses. *Crown 4 to. 392 pages, 210 illustrations. Net 42s.*

Complete Catalogue of Technical Books sent on request.

ERNEST BENN LIMITED, BOUVERIE HOUSE, FLEET ST., LONDON, E.C.4



PHOTOGRAPHIC HYPO

Write for samples, prices and full information to the nearest Area Sales Offices of

IMPERIAL CHEMICAL INDUSTRIES LIMITED

at Belfast, Birmingham, Bradford, Bristol, Dublin, Glasgow, Leicester, Liverpool, London, Manchester or Newcastle-on-Tyne

Head Office: Imperial Chemical House, London, S.W.1.

C.N.70

MANUFACTURERS AND PROPRIETORS OF

"INVICTA"
DECOLOURISING CARBON

PLUMBAGO

WOOD AND ANIMAL
CHARCOAL

MANGANESE

"INVICTA"
BITUMINOUS MATERIALS FOR ROAD CONSTRUCTION

ESTABLISHED 1830

OLD-ESTABLISHED yet up-to-date in every detail, this organisation provides a specialised service for the chemical industry that ensures rapid delivery and low prices all the time.

GRINDING

Of every description of chemical and other materials for the trade with improved mills.

THOMAS HILL-JONES, LTD.

MANUFACTURING CHEMISTS

INVICTA WORKS, BOW COMMON LANE, LONDON, E.3

and at MEESON'S WHARF, BOW BRIDGE, E.15 :: CONTRACTORS TO H.M. GOVERNMENT

Telephones : EAST 3632 and 3633 Telegrams : Hill-Jones, Pop, London

The GAS LIGHT & COKE CO

Dauntsey House, Frederick's Place, Old Jewry, London, E.C.2.

Telephones: Metropolitan 9362, 9363, 9364. Telegrams: { Inland: "Blangus, Thread, London." Foreign: "Blangus, London."

The Chemical Age

A Weekly Journal Devoted to Industrial and Engineering Chemistry

Vol. XXVIII, No. 730 Published every Saturday June 24, 1933

CONTENTS

PAGE

NOTES AND COMMENTS

Exports and Imports of Chemicals—Sir George Clayton—Activities of the Imperial Institute—Health and Efficiency—Science and Crime 565-566

LETTERS TO THE EDITOR

Educated Unemployed (British Executive Employment Society) 576

FEATURES

Applications of Cellulose Esters and Ethers 567
Rotenone as an Insecticide 568-569
Gas Engineers Visit Spain and Portugal 569
Scale Prevention in the Boiler. By E. A. Smith 570-571
Computation of Profits for Income Tax Purposes. By S. Howard Withey 571
Recent Developments in Textile Printing. By L. G. Laurie . . . 572
Coal Tars for Road Making. By Professor Dr. Mallison, Berlin . 573-574
The Dimethyl Glyoxime Reaction for Nickel. By Edwin C. Righellato 574
Fermentation Processes 575
Transparent Paper 575
World Power Conference Delegation 575
Phenolic Resins 575
The Need for Efficient Machinery Guards—Wire Mesh and Perforated Material 576-577
British Overseas Chemical Trade in May 578
Kali-Chemie A.G. 579
Etablissements Kahlmann 579
The French Chemical Society 579
Misleading Food Labels 579
Wages in the Dyeing Industry 579
Dr. M. Polanyi's Appointment 580
Controlling the Big Business 580

News from the Allied Industries 580
Inventions in the Chemical Industry 581
Weekly Prices of British Chemical Products 582-583
New Companies Registered 584
New Chemical Trade Marks 584
Chemical Trade Inquiries 584
Company News 584
From Week to Week 585

Publishers' Notice

A copy of THE CHEMICAL AGE will be sent every week to an address in the United Kingdom for 21/- per annum. The prepaid subscription for addresses abroad is 26/- per annum. Cheques, Money Orders, and Postal Orders should be made payable to Benn Brothers, Ltd. On publication of THE CHEMICAL AGE YEAR BOOK in December, a copy will be sent to every subscriber on our books.

Communications relating to editorial matter should be addressed to the Editor, who will welcome contributions dealing with modern chemical developments. Communications relating to advertisements, subscriptions or general matters should be addressed to the Advertisement Manager.

PUBLISHED FROM BOUVERIE HOUSE, 154, FLEET ST., LONDON, E.C.4

Telegrams: ALLANGAS FLEET LONDON. Telephone: City 0244 (10 lines).

(Closed on Saturdays in accordance with the adoption of the five-day week by Benn Brothers, Limited.)

ACID PROOF

Apply to . .

THE LIMMER & TRINIDAD LAKE ASPHALT CO. Ltd.
Artillery House, Artillery Row - - London, S.W.1
for particulars of

ACETAS ASPHALT

ASPHALT

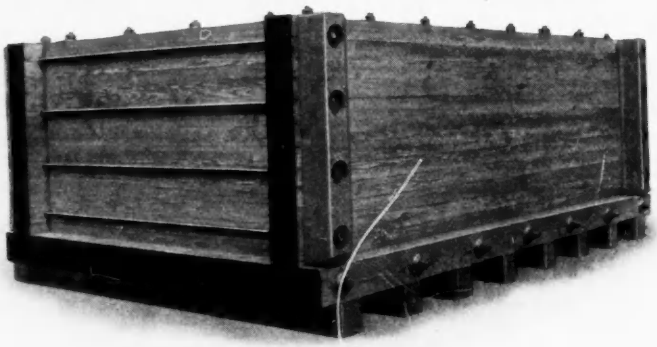
WOOD VATS & TANKS

50 Gallons to 150,000 Gallons Capacity

Carty's specialise exclusively in the manufacture of Wood Vats and Tanks for all trades, and are famous for the reliability and long life of their vessels.

The Secret of this Success is—

1. Properly seasoned Timber.
2. Strict elimination of natural defects from Timber.
3. The accumulated experience of over 150 years' continuous manufacture of Chemical Vessels.



Unlined Pickling Tank for Holding Boiling Sulphuric Acid.

CARTY & SON LTD.

HARDERS ROAD, PECKHAM, LONDON, S.E.15.
PHONE: NEW CROSS 1826 EST. 1766

FOR SALE

(1s. per line; minimum charge 3s. Sixpence extra is charged when replies are addressed to Box Numbers.)

BROUGH'S Patent Indestructible Drums and Kegs, also Plain Welded, Double-seamed or Corrugated Drums and Kegs, of every description, from 1 to 80 gallon.—4 Upper Parliament Street, Liverpool. Telephone: Royal 2685. Telegrams: Superdrum, Liverpool.

CHARCOAL, ANIMAL and VEGETABLE, horticultural, burning, filtering, disinfecting, medicinal, insulating; also lumps ground and granulated; established 1830; contractors to H.M. Government.—THOS. HILL-JONES, LTD., "Invicta" Mills, Bow Common Lane, London, E. Telegrams: "Hill Jones Pop., London." Telephone: 3633 East.

HYDRAULIC PRESSES AND PUMPS. Large stock in London. Price quoted for adapting and erecting.—THOMPSON AND SON, Maria Street, Millwall.

MIXERS by Werner and other makers, jacketed pans, disintegrators, grinders, good stock.—C. F. DAVIS, LTD., Hatcham Road, Old Kent Road, London, S.E.15.

'Phone 98 Staines.

PAIR of Vacuum Ovens, 10 hollow Shelves 4 ft. x 4 ft., with Pump and Condenser. Film Drying Rolls 6 ft. x 4 ft.: Werner Jacketed Mixer, 60 galls.: 1,000 gallon Jacketed Mixing Pan: Scott Spirit Still, 100 gallons.
HARRY H. GARDAM AND CO., LIMITED, STAINES.

TWO WORKS THERMOMETERS, Griffin and Tatlock, nearly new, cost £6. 12in. Face: 48 in. stem 0/360° C., and 3 in. stem 0/500° C. Write: 38 Nicoll Road, Harlesden, N.W.10.

WANTED

(1s. per line; minimum charge 3s. Sixpence extra is charged when replies are addressed to Box Numbers.)

GRINDING of every description of chemical and other materials for the trade with improved mills.—THOS. HILL-JONES, LTD., "Invicta" Mills, Bow Common Lane, London, E. Telegrams: "Hill-Jones, Pop., London." Telephone: 3633 East.

EDWARD RUSHTON, SON AND KENYON (Established 1855).
Auctioners' Valuers and Fire Loss Assessors of
CHEMICAL WORKS, PLANT AND MACHINERY
York House, 12 York Street, Manchester.
Telephone: 2517 and 2518 Central, Manchester.
Telegrams: "Russonken, Manchester."

PATENTS & TRADE MARKS

(1s. per line; minimum charge 8s.)

KINGS PATENT AGENCY, LTD. (B. T. King, Registered Patent Agent, G.B., U.S., and Can.), 146a Queen Victoria Street, London, E.C.4. "Advice Handbook," and Cons. free; 47 years' ref. 'Phone: Central 0682.

ADVICE on Protection of Inventions and Registration of Trade Marks. Send for free booklets. REGINALD W. BARKER AND CO., Patent Agents, 56 Ludgate Hill, E.C.4. (Estab. 46 years.) Telephone: Central, 1882.

PATENTS obtained, trade marks and designs registered, at home and abroad.—GEE AND CO. (Patent and Trade Mark advisers to THE CHEMICAL AGE), 51-52 Chancery Lane, London, W.C.2. Telephone: Holborn 1525. Established 1905.

THE PROPRIETOR of British Patent No. 330,146, dated March 11, 1929, relating to "CALCINED BORAX AND PROCESS OF PRODUCING SAME," is desirous of entering into arrangements by way of a licence or otherwise on reasonable terms for the purpose of exploiting the above patent and ensuring its practical working in Great Britain. Inquiries to B. Singer, Steger Building, Chicago, Illinois.

BUSINESS OFFER

(1s. per line: minimum charge 3s.)

BUSINESS OPPORTUNITY.

German chemical factory which intends to manufacture one of its products in Great Britain is desirous of entering into relation with firms which are disposed to join this undertaking.

Apply to "B.N. 3014," Ala Anzeigen-Aktiengesellschaft, Berlin, W.35.

At Attractive Prices ex site St. Helens, Leigh and Manchester.

Experimental Sulphuric Acid Plant, leadlined and with Regulus Metal Valves. Filter Presses, Johnson type, 10 chambers, 12" × 12". Several 3,000 gals. Enclosed and Open Top Glass lined Tanks. Unused Monel Metal Cage, lead-cased, belt-driven Hydro Extractor, bottom side discharge. 1½" and 2" Porcelain lined "Ceratherm" Pumps by Guthrie. 6" × 3" Ebonite Reciprocating Pump. 40" Motor-driven Hydro Extractor, underdriven (A.C. current) and with lid and automatic locking device to the latter. 32½ h.p. 3-phase A.C. Motor, 1,440 revs. Lancs Dynamo. One Washing, Bleaching and Desulphidising Plant with bakelite-lined tanks, etc. 1½" motor-driven (A.C.) Pump for 220 or 380-400 volts 68 Grading Stands and Stools for textile Works' use. 62" Cloth-Plaiting Machine.

SPECIAL.— ALMOST NEW!

2 Frequency Changer Sets, each with 50 k.w. Synchronous Motor (100 cycles, 400 volts, 1,200 revs.) to drive 125 k.w. Asynchronous Motor 400 volts, 50 cycles, 1,200 revs., together with 4 panel slate switchboard and 4-125 K.V.A. Oil-cooled Transformers by Siemens (two 209 amps. primary—71 amps. secondary and two L.T. 520 volts, and H.T. 560 volts) with bus-bar connections, switchboard, etc. New Rubber-lined Tank, and 26 Bakelite-lined Tanks, 125, 180 and 340 galls. 1930 Washing and Drying Machine for plate-glass, etc.

Clearing from Bristol.

Air Receiver, 5' × 18' × 100 lbs. working pressure; almost new. Two 2,500 galls. Enclosed Jacketted Mixers (4 mixing gears). 1 cubic yard Grab (useful for many purposes). 40-cwt. Pooley Weighing Machine for narrow gauge (Jubilee) Wagons or dormant use.

Also

2 New 3-ton Morris Electric Single-girder Hoists. Electrically heated Insulated Varnish Tank with Mixing Gear. Four 26" "K.E.K." Grinding Mills and No. 2 "Miracle" Mill. "Marvel" Size 2 Tabletting Machine for up to 3,000 tablets per hour. New 14" × 28" Horizontal Steam Engine 50 h.p. at 90 lbs.

OLIVER ASHWORTH & Co., CASTLE GROUNDS, BURY. LANCS.
Telephone: 1533 4.

TAPS OF LIGNUM VITAE

Cut by a Special Patent Process No Cork Centres; very Durable. All Sizes from ⅜ in. to 1 in. Bores.

PREMIER FILTERPRESS CO. LTD.
Finsbury Pavement House, London, E.C.2.

Snow-White Light Oxide of Tin. Copper Oxide.

Oxides of :—
ANTIMONY.
COBALT.
CHROME.
MANGANESE.
NICKEL.
SELENIUM.
TITANIUM.
URANIUM.
ZINC.

CADMIUM SULPHIDE, RUTILE.

All kinds of Chemicals for Vitrifications.

PYRAMID CONES for Testing Temperatures

TODD'S "AWLTOPLID" DRUM
The Steel Package with the full open top

Makers of ALL KINDS OF LIGHT STEEL
DRUMS & KEGS

TODD BROS.
Phone: 167 WIDNES Grams: "TODD"

IRONAC METAL FOR RESISTING ACIDS
HAUGHTONS P.M.P. CO. LTD.
30, ST-MARY-AT-HILL, LONDON.E.C.3.

HOPKIN & WILLIAMS Ltd.
MANUFACTURERS OF FINE CHEMICALS

Announce the publication of

"ORGANIC REAGENTS for METALS"

Describing the use of 17 organic substances in the detection and estimation of metals.
61 Pages - - - Price 1/3 post free.

16 & 17, CROSS STREET - LONDON, E.C.1

A MERCHANT ADVENTURER IN SOUTH AMERICA
By John A. Benn.
Cr. 8vo. 6s. Net.

"Full of good sense and practical comment."
—*Evening News.*

"Combines all the fascination and attractions of a book of travel with the keenest insight into conditions in South America as a field for greater development of British trade."
—*Aberdeen Press.*

"Simply written and disarming in its fervour."
—*Belfast News Letter.*

"Mr. Benn is a constructive critic."
—*The Times.*

"Amid the depressing literature about our declining foreign trade, Mr. Benn's book provides a welcome change."
—*Financial News.*

"Should be read by all who are concerned in overseas trade."
—*Shipping World.*

ERNEST BENN LIMITED
154, Fleet Street, London, E.C 4